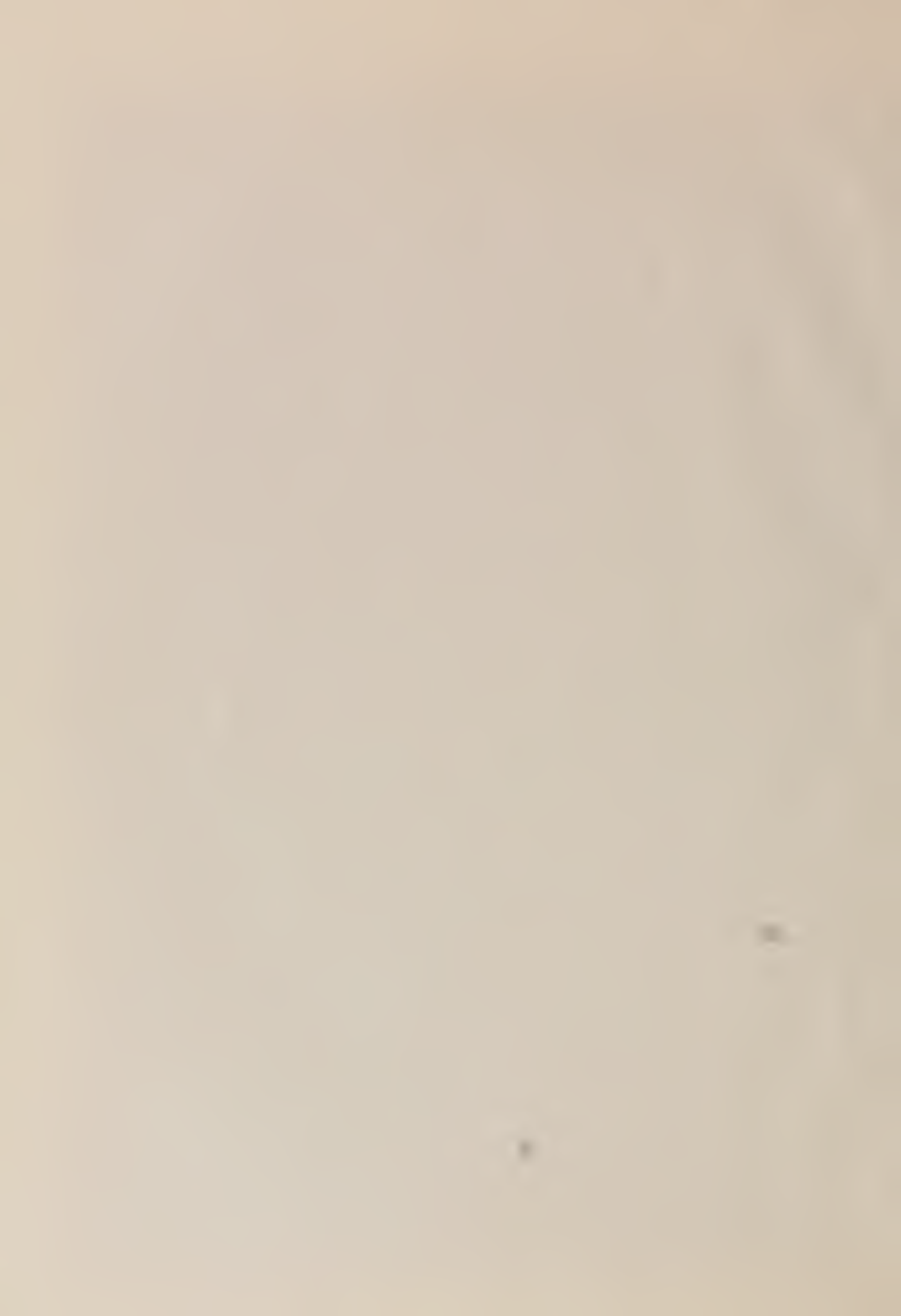


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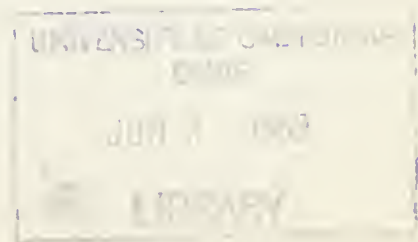
ORANGE COUNTY
LAND AND WATER USE
SURVEY, 1957

EDMUND G. BROWN
Governor



HARVEY O. BANKS
Director of Water Resources

JANUARY, 1959

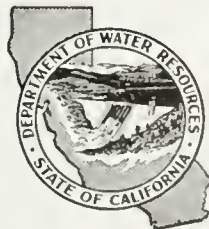


STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

BULLETIN NO. 70

ORANGE COUNTY LAND AND WATER USE SURVEY, 1957

EDMUND G. BROWN
Governor



HARVEY O. BANKS
Director of Water Resources

JANUARY, 1959

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Laguna
Beach
May, 1957

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Garden
Grove
June, 1958

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STATE OF CALIFORNIA
Department of Water Resources

SACRAMENTO

February 16, 1959

Honorable Edmund G. Brown, Governor
and Members of the Legislature of
the State of California

Gentlemen:

I have the honor to transmit herewith Department of Water Resources Bulletin No. 70. entitled "Orange County Land and Water Use Survey, 1957". The investigation was conducted as a part of the continuing studies authorized by Chapter 832, Statutes of 1929. The statute directed that exploration and investigation be conducted in furtherance of a coordinated plan for the conservation, development and utilization of the water resources of California.

The purpose of the investigation was to determine the present net water use in Orange County. In addition, it was desired to evaluate historic changes in net water use and to compare present net water use with the probable ultimate water requirements set forth in State Water Resources Board Bulletin No. 2, "Water Utilization in California". In accomplishing the foregoing purpose, the nature and extent of the various categories of land use in Orange County were determined and unit values of water use were ascertained. Continued studies of this type are a necessary part of the basic data required for proper operation of the ground water basins and for adequate planning and design of facilities for utilization of imported water.

It is found that the large population increases caused an increase of about 145 per cent between 1948 and 1957 in the gross urban and suburban area in Orange County. This increase occurred primarily on land previously devoted to irrigated agriculture, principally citrus orchards. During the nine year period, the mean seasonal water requirement increased about 3 1/2 per cent to approximately 244,000 acre-feet per season. However, with full development of the habitable area of the County, the water requirements will increase about 240 per cent, to a total of 825,000 acre-feet, 670,000 acre-feet in excess of the safe yield of local water resources. Under present conditions, Orange County's theoretical entitlement to Colorado River water is estimated to be between 80,000 and 90,000 acre-feet per year.

Efforts are being made by local water agencies to purchase and spread Colorado River water for artificial replenishment of the local ground water supplies to meet the current deficiencies and to gradually replace

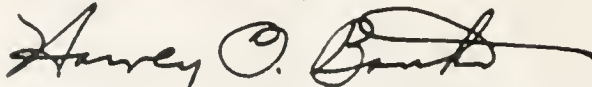
Honorable Edmund G. Brown,
Governor

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February 16, 1959

the depletion in ground water storage resulting from long, continued overdrafts. However, satisfaction of Orange County's ever-increasing water requirements, together with those for other areas in southern California, necessitates the early importation of water from northern California.

Very truly yours,

A handwritten signature in dark ink, appearing to read "Harvey O. Banks", with a long, sweeping horizontal stroke extending to the right.

HARVEY O. BANKS
Director

ACKNOWLEDGMENT

Valuable assistance and data used in this investigation and report were contributed by public and private agencies. Special mention is made of the cooperation received from the following:

Orange County Water District

Orange County Department of Agriculture

County Sanitation Districts of Orange County

Orange County Board of Supervisors

The cooperation and assistance received from these agencies is gratefully acknowledged.

ORGANIZATION
STATE DEPARTMENT OF WATER RESOURCES

Harvey O. Banks Director of Water Resources
M. J. Shelton Deputy Director of Water Resources*
Ralph M. Brody. Deputy Director of Water Resources
William L. Berry Chief, Division of Resources Planning

Activities of the Southern California
District Office are under the direction
of

Max Bookman District Engineer
Otto C. von Seggern Supervising Hydraulic Engineer

This bulletin was prepared in the Data Section
under the direction
of

Donald H. McKillop Senior Hydraulic Engineer
by

Robert H. Born Associate Hydraulic Engineer
Roger E. Stephenson Assistant Civil Engineer
assisted by

Robert Bond Assistant Civil Engineer
Robert L. Dahlquist Assistant Land and Water Use Analyst
L. John Harthan Junior Civil Engineer
John Heza Engineering Aid II

Staff Supervision of Land and Water Use Studies
is exercised by the
Division of Resources Planning

Irvin M. Ingerson Chief, Engineering Services Branch
John W. Shannon Supervisor, Land and Water Use Unit

P. A. Towner, Chief Counsel
Paul L. Barnes, Chief, Division of Administration
Isabel C. Nessler, Coordinator of Reports

*Deputy Director July 1956 to January 15, 1958.

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CHAPTER I. INTRODUCTION

The growth of population and industry and the resulting decrease in irrigated agricultural acreage have created changes in the character and amount of the demand for water in Orange County. A periodic survey of land use and an evaluation of the effect of land use changes upon the requirements for and the availability of water are necessary to provide the basic data required for the planning for present and future developments designed to provide adequate water supplies.

All of southern California has experienced a tremendous growth in population during the past several decades. In Orange County this growth has been even more impressive. This is particularly true of the period 1950 through 1957, during which time the population nearly tripled to an estimated 600,000. Coincident with this increase in population, there has been a large increase in land used for residential and industrial purposes. The increases in urban area have occurred for the most part at the expense of irrigated agriculture, which decreased in gross area approximately 25 per cent between 1948 and 1957.

The establishment of a firm agricultural economy and the development of urban and industrial areas are contingent upon the existence of a readily available source of water. Historically, in Orange County most of the water used was drawn from the underlying ground water basins. The ever-increasing demand for water has resulted in an overdraft on the ground water.

Beginning in 1941, an increasing proportion of water used in Orange County has been obtained by importation of water from the Colorado River through the facilities of The Metropolitan Water District of Southern

California. The delivery of this imported water through surface distribution facilities has replaced water that otherwise would have been pumped. Beginning in 1949 imported water has also been used for recharge of the ground water basins by spreading in and adjacent to the stream bed of the Santa Ana River. The net result of these operations has been a reduction in overdraft.

Authorization

The Legislature, by Chapter 832, Statutes of 1929, directed that exploration and investigation be conducted for furtherance of a coordinated plan for the conservation, development, and utilization of water resources of California. As a result of this legislation, the Department of Water Resources (then Division of Water Resources, Department of Public Works) undertook a continuing hydrologic investigation of the southern California area, including land and water use studies.

Related Investigations and Reports

In accordance with action of the California Legislature of 1947, Chapter 1541, Statutes of 1947, and subsequent annual appropriations of funds, the Department of Water Resources and its predecessor agencies conducted a comprehensive investigation of the water resources of the entire State of California. The investigation had for its purpose the preparation of The California Water Plan. Results of the investigation are contained in three publications: California State Water Resources Board Bulletin No. 1, "Water Resources of California", 1951; California State Water Resources Board Bulletin No. 2, "Water Utilization and Requirements of California", June, 1955; and California State Department of Water Resources Bulletin No. 3, "The California Water Plan", May, 1957. The investigations for Bulletin No. 2 included a survey of land use in 1948 and water requirements in Orange County for conditions of 1950.

The following reports contain information pertinent to land and water use within Orange County:

Bailey, Paul. "Engineer's Report on Ground Water Conditions in the Orange County Water District". March, 1957.

Bailey, Paul. "Engineer's Report on Ground Water Conditions in the Orange County Water District". March, 1958.

California State Department of Public Works, Division of Water Resources. "Pacific Slope of Southern California". Bulletin No. 30 (Unpublished).

California State Department of Public Works, Division of Water Resources. "Geology and Ground Water Storage Capacity of Valley Fill". Bulletin No. 45. 1934.

California State Department of Public Works, Division of Water Resources. "Present Overdraft on, and Safe Yield from, the Ground Water of the Coastal Plain of Orange County". June, 1945.

California State Department of Public Works, Division of Water Resources. "South Coastal Basin Investigation, Overdraft on Ground Water Basins". Bulletin No. 53. 1947.

California State Water Resources Board. "Central Basin Investigation". Bulletin No. 8. March, 1952.

California State Water Resources Board. "Santa Ana River Investigation". (Preliminary) Bulletin No. 15. April, 1956.

Hall, William Hammond, State Engineer. "Report of the State Engineer to the Legislature of the State of California, Session of 1880". Part IV, Appendix on Irrigation in San Bernardino and Los Angeles Counties. 1880.

Hall, William Hammond, State Engineer. "Irrigation in Southern California". 1888.

Mendenhall, Walter C. "Development of Underground Waters in the Western Coastal Plain of Southern California". United States Department of Interior, Geological Survey, Water Supply and Irrigation. Paper No. 139. 1905.

Morris, R. I. "Orange County Progress Report". Volume I. No. 9. March, 1958.

In other parts of the State investigations have been initiated pursuant to Section 232 of the Water Code, known as the "Regan Investigation". These studies have as their purpose, the determination of the

following matters: (a) The boundaries of the respective watersheds of the State and the quantities of water originating therein; (b) The quantities of water reasonably required for ultimate beneficial use in the respective watersheds; (c) The quantities of water, if any, available for export from the respective watersheds; and (d) The areas which can be served by the water available for export from each watershed. The data collected in this investigation and reported on herein are similar to some of the data being collected for the "Regan Investigation" and can serve as a basis for such an investigation in the studied area at a later date.

Scope of Investigation and Report

The Orange County Land and Water Use Survey included field surveys and office studies to determine the nature and extent of present land use and net water use. A further objective of the studies was the preparation of estimates of present supplemental water requirements and comparison of the results of the studies with similar data available for prior years, as well as with projected ultimate conditions.

Full use was made of land use, land classification, and ultimate water requirement studies developed in connection with the preparation of State Water Resources Board Bulletin No. 2, along with the methods and procedures used therefor. In addition, studies were made of importation of water and exportation of sewage and the historic effect of changes in these items on supplemental water requirements of Orange County.

Present land use in the area of investigation was determined from a detailed field survey conducted during the summer of 1957. In addition, a review was made of unit values of water use derived in connection with the preparation of State Water Resources Board Bulletin No. 2 in order to evaluate their applicability

to 1957 conditions of development. In this review, primary attention was given to possible changes in industrial water use. Data obtained from unit value of water use studies were used in conjunction with land use surveys to determine present net water use. The safe yield of local water supplies was evaluated from basic data contained in the files of the Department of Water Resources. Supplemental water requirements were derived as the difference between net water use and safe yield of local water supplies.

Results of the Orange County Land and Water Use Survey of 1957 are presented in the three ensuing chapters of this report. Chapter II, entitled "Land Use", includes data on present land use and changes in land use within the investigational area, together with a discussion of methods and procedures utilized in the derivation thereof. Chapter III, "Net Water Use", contains data on unit values of water use and net water use by various categories of land use, together with a brief discussion of water supply conditions. Chapter IV, "Summary of Findings", contains a brief summary of the results of the investigation.

The following definitions of certain terms and concepts, as used in this report, are presented to facilitate understanding of the ensuing subject matter.

Annual - The 12-month period from January 1st of a given year through December 31st of the same year, sometimes termed the "calendar year".

Seasonal - Any 12-month period other than the calendar year.

Mean Period - A period chosen to represent conditions of water supply and climate over a long series of years. For purposes of the current investigation, the mean precipitation period embraces the 50 seasons from 1897-98 through 1946-47, and the mean runoff period, the 53 seasons from 1894-95 through 1946-47.

Mean - An arithmetical average relating to a mean period.

Average - An arithmetical ~~average~~ relating to a period other than a mean period.

Present - Land use and water supply conditions prevailing during the 1956-57 season.

Ultimate - Refers to conditions after an unspecified but long period of years in the future when land use and water supply development will be at a maximum and essentially stabilized.

Water Utilization - This includes all employments of water by nature or man, whether consumptive or nonconsumptive, as well as irrecoverable losses of water incidental to such employment, and is synonymous with the term "water use".

Water Requirement - The water needed to provide for all beneficial uses and for all irrecoverable losses incidental to such uses.

Applied Water Requirement - The applied water needed to provide for all beneficial uses and for all irrecoverable losses incidental to such uses.

Net Water Use - Water historically applied or estimated to have been applied to provide for all beneficial uses and for those irrecoverable losses incidental to such uses with due regard to the possible reuse of that portion of the applied water which is not consumptively utilized. This term differs from "applied water requirement" which relates to the quantity required for development; whereas "net water use" relates to the historic amount actually applied. Under conditions where the historic net water use has been equal to the requirement, the terms are synonymous.

Present Supplemental Water Requirement - The additional water needed to provide for all present beneficial consumptive uses of water and for irrecoverable losses incidental to such use over and above the safe yield of the present local water supply development.

Consumptive Use of Water - Water consumed by vegetative growth in transpiration and building plant tissue, and to water evaporated from adjacent soil, from water surface, and from foliage. It also refers to water similarly consumed and evaporated by urban and nonvegetative types of land use.

Applied Water - Water delivered to a farmer's headgate in the case of irrigation use, or to an individual's meter in the case of urban use, or its equivalent. It does not include direct precipitation.

Irrigation Efficiency - The ratio of consumptive use of applied irrigation water to the total amount of water applied, expressed as a percentage.

Aquifer - A geologic formation or structure sufficiently permeable to yield water to wells or springs.

Free Ground Water - A body of ground water not immediately overlain by impervious materials.

Confined Ground Water - A body of ground water immediately overlain by material sufficiently impervious to sever free hydraulic connection with overlying water, and moving under pressure caused by the difference in head between the intake or forebay area and the discharge area of the confined water body.

Safe Yield - The average annual net amount of water that could be beneficially extracted from a ground water basin over an indefinitely long period of years, under a particular set of those physical conditions affecting supply to and disposal from the ground water basin, without causing a net lowering of ground water levels during the period.

Safe Yield of Local Supplies - The safe yield of a ground water basin under an assumed condition of no imported supply from an outside source.

Ground Water Overdraft - The rate of net extraction of water from a ground water basin in excess of safe ground water yield.

Quality of Water - Those characteristics of water affecting its suitability for beneficial uses.

Area Under Investigation

The area under investigation, broadly designated "Orange County Area", includes all of Orange County except for small areas in the eastern part of the county which drain into the Upper Santa Ana River Basin. In addition, it includes those portions of Los Angeles and San Bernardino Counties tributary to Carbon Canyon, and those portions of San Bernardino and Riverside Counties tributary to the Santa Ana Narrows below Prado Dam. The general location of the area of investigation is shown on Plate 1, "Location of Investigational Area" and detailed on Plate 2, "Major Water Agencies and Hydrologic Units in Orange County Area, 1957".

Location and Description

The Orange County Area comprises an area of about 824 square miles. It is roughly rectangular in shape and extends some 35 miles parallel to the Pacific Ocean with an inland depth of about 25 miles. The coastal plain of Orange County includes about 530 square miles of valley land lying between the Puente Hills and Santa Ana Mountains on the north and northeast and the Pacific Ocean on the southwest, and extending from the Los Angeles County line on the northwest to the San Joaquin Hills on the southeast. Aliso Creek Basin is a small basin joining the southeasterly side of the coastal plain area in the vicinity of El Toro and running to the ocean in a southerly direction. San Juan Creek Basin lies in the hilly terrain of the southeasterly portion of the county and includes lands adjacent to San Juan Creek and its tributaries.

The remainder of the Orange County Area is very hilly. The Puente Hills and San Joaquin Hills, which attain elevations of about 1,800 and 1,200 feet respectively, are relatively smooth. The Santa Ana Mountains are more rugged and rise to an elevation of 5,700 feet.

The Santa Ana River, the principal stream in Orange County, rises in the San Bernardino and San Gabriel Mountains some 50 to 90 miles inland and passes through portions of Riverside and San Bernardino Counties. It enters Orange County by way of a twelve-mile gorge, known as the Santa Ana Narrows, which exists between the Puente Hills and the Santa Ana Mountains, and flows in a southwesterly direction across the coastal plain to the Pacific Ocean.

Precipitation in Orange County varies widely both seasonally and geographically and generally occurs in the form of rainfall. Mean seasonal rainfall at the City of Santa Ana for the 50-year period 1897-1947 is 14.16 inches, ranging from a maximum of 34.34 inches during the 1940-41 season to a minimum of 6.61 inches during the 1893-94 season. At Camp Silverado in the Santa Ana Mountains mean seasonal rainfall is 24.87 inches. The maximum recorded rainfall at this station was 48.73 inches during the 1940-41 season, while the minimum recorded rainfall was 15.18 inches during the 1950-51 season.

Generally the temperature range is rather small. At Santa Ana the mean temperature is 62° Fahrenheit with recorded extremes of 22°F and 112°F. Killing frosts and temperatures exceeding 100°F are of infrequent occurrence. Loss of semi-tropical crops is usually prevented during heavy frosts by use of artificial heating devices or wind-making machines.

For study purposes, the Orange County Area has been divided into three hydrologic units, primarily on the basis of topographic and geologic considerations. These units are designated the La Habra Hydrologic Unit, Coastal Plain Hydrologic Unit, and San Juan Capistrano Hydrologic Unit and are delineated on Plate 2. Gross areas of these units are presented in Table 1.

TABLE 1

GROSS AREAS OF HYDROLOGIC UNITS
ORANGE COUNTY AREA

In Acres

Hydrologic unit	:	Area
La Habra	:	18,013
Coastal Plain	:	339,266
San Juan Capistrano	:	<u>170,328</u>
TOTAL	:	<u>527,607</u>

The Coastal Plain of Orange County is comprised of absorptive Pleistocene marine, continental, and Recent alluvial deposits. These deposits are underlain by and, with the exception of the boundary with the adjacent Coastal Plain of Los Angeles County, surrounded by formations generally considered to be essentially nonwater-bearing. The more permeable of the quaternary and tertiary deposits contain ground water which is extracted for beneficial use. Surface stream flow and precipitation as well as water imported for artificial replenishment enter these aquifers principally in the forebay or nonpressure areas primarily through the pervious bed of the Santa Ana River. In the westerly portion of the Coastal Plain the ground water is generally confined. Deep percolation of precipitation to the confined aquifers is restricted by the presence of sandy clay or clay strata of relatively low permeability overlying the important pumped aquifers. The approximate boundary between the pressure and nonpressure area is delineated on Plate 3, "Ground Water Basins in Orange County Area".

The La Habra Unit is comprised of absorptive marine and continental deposits. The unit occupies the long east-west synclinal trough between the

Santa Fe Springs-Coyote Uplift and the Puente Hills. It runs easterly from the San Gabriel River Cone and is subdivided from the Yorba Linda Basin on the east by the East Coyote anticline. The unit is made up of two zones of water-bearing material. The upper zone deposits are entirely continental and are primarily alluvial material derived locally from the Puente Hills. They are replenished by percolation runoff from the Puente Hills, rainfall on the valley floor, and deep penetration of excess applied water. The lower zone is principally of marine origin, but some continental beds do occur. This zone is replenished by percolation of rainfall and runoff in areas of outcrop and by percolation of water from the upper zone.

The San Juan Capistrano Unit, including the drainages of San Juan and Aliso Creeks, is characterized by relatively long narrow alluvial valleys in the lower reaches of the main streams. Smaller valleys of the same type are also dispersed about the inland area at higher stream elevations where favorable conditions exist for the deposition of detritus above contractions in the rock formations. Most of these formations are derived from sediments of marine origin, and only about 10 per cent may be considered to be water bearing or potentially water bearing.

Population

Orange County has experienced outstanding growth during the past several decades. With the exception of the depression period, the rate of population growth of Orange County has exceeded that of the entire State of California for every decade since 1890. Furthermore, since 1940, the rate of population growth, percentage wise, has exceeded that

of the ten southernmost counties of the State, including that of neighboring Los Angeles County. At the time of the 1950 census the population of the county was 216,000. On July 1, 1957, the California State Department of Finance, in a report entitled "California Population", estimated the county population to be 520,000, which represents an increase over the 1950 population of about 140 per cent. The "Orange County Progress Report", Volume 1, Number 9, dated March 1958, prepared for the Orange County Board of Supervisors by R. I. Morris and based primarily upon special censuses, contained an estimate that the population on December, 31, 1957, exceeded 610,000. This is nearly three times the 1950 population.

The "Orange County Progress Report" contains an estimate to the effect that 66 per cent of the county's population resided within its incorporated cities. In 1950 there were thirteen such cities. Since that date eight new cities have been incorporated. Since 1950, nine of the largest cities in Orange County have increased in population by more than 100 per cent. Of these, seven have recorded increases in population exceeding 200 per cent. The most phenomenal increase has been in the City of Garden Grove, which grew from an unincorporated community of 3,800 persons in 1950 to a city of 58,500 in 1957, an increase of over 1550 per cent.

Table 2 lists the twenty-one incorporated cities in Orange County with their reported populations in 1940, 1950, and the estimated 1957 population as prepared by the Orange County Planning Commission. The per cent of increase in population from 1940 to 1950 and 1950 to July, 1957, is also shown. The recent growth of population in incorporated areas is depicted graphically on Plate 4, "Population Growth of Principal Incorporated Cities in Orange County", while the population growth in relation to other parts of

California is delineated on Plate 5, "Comparison of Population Increases of Orange County with those of Los Angeles County, 10 Southernmost California Counties and State of California".

TABLE 2

POPULATION OF
INCORPORATED CITIES IN ORANGE COUNTY

City	: 1940	: 1950	: 1957 ^a	Increase in per cent	
	: Census	: Census	: Estimate	: 1940 to 1950	: 1950 to 1957
Anaheim	11,031	14,556	65,000	32	347
Brea	2,567	3,208	6,500	25	103
Buena Park	Uninc.	5,483 ^b	27,000	--	392
Costa Mesa	Uninc.	11,844 ^b	23,000	--	94
Cypress	Uninc.	Uninc.	1,700	--	--
Dairyland	Uninc.	Uninc.	600	--	--
Fountain Valley	Uninc.	Uninc.	600	--	--
Fullerton	10,442	13,958	46,000	34	230
Garden Grove	Uninc.	3,762 ^b	58,500	--	1,555
Huntington Beach	3,738	5,237	12,300	40	135
Laguna Beach	4,460	6,661	8,500	49	28
La Habra	2,499	4,961	15,000	99	202
Newport Beach	4,438	12,120	21,200	173	75
Orange	7,901	10,027	20,000	27	99
Placentia	1,472	1,682	3,200	14	90
San Clemente	479	2,008	7,400	319	269
Santa Ana	31,921	45,533	71,200	43	56
Seal Beach	1,553	3,553	4,200	129	18
Stanton	Uninc.	Uninc.	4,600	--	--
Tustin	953	1,143	1,800	20	57
Westminster	Uninc.	3,131 ^b	14,200	--	354

a. Orange County Planning Commission estimate for July 1, 1957.

b. U. S. Census count of unincorporated communities, shown for comparative purposes.

Agriculture

The first known agricultural development in Orange County occurred in the vicinity of the Mission San Juan Capistrano as early as 1776. Prior to the turn of the present century the principal source of revenue was the raising of cattle pastured on native grasses and dry farm stubble. However, some irrigated agriculture, primarily truck crops and wine vineyards, did exist. Water for irrigation was obtained by diversions from the Santa Ana River and other streams, although shallow dug wells were developed during the latter part of the nineteenth century to provide firm supplies during the late summer and fall.

Commencing about the year 1900, the planting of orchards, primarily citrus, became common. The greatest influence on the expansion of agricultural development was the introduction of the deep well turbine pump. Use of ground water resulted in an increase of approximately 350 per cent in agricultural acreage between 1904 and 1926. By 1948 there were 136,600 gross acres of irrigated agriculture in the County. The principal crops included citrus, avocados, walnuts and other deciduous fruits, truck crops, and alfalfa.

The past nine years have seen a great change in Orange County agriculture. The advent of industrial and urban development in both Orange and Los Angeles Counties has changed the pattern of land use. Orchards, including citrus and deciduous trees, are being replaced by new urban developments, truck farms, or animal industry. The Orange County Department of Agriculture reported in the "Agricultural Crop Report, 1951", that, at peak development, these orchards covered as

much as 84,000 acres. By 1957, only about 49,500 acres of orchards were productive.

It is to be noted that while much of the decrease in orchard acreage has been due to urbanization and industrialization there has also been an increase in acreage devoted to truck crops and animal industry of all types. In "Agricultural Crop Report, 1957", issued by the Orange County Department of Agriculture, it is indicated that the animal industry including dairy, eggs, beef cattle, hatcheries, and turkeys has increased in gross value from \$14,700,000 in 1947 to \$44,400,000 in 1957. During this period irrigated truck crop acreage increased from 16,700 to 20,300 acres. These changes have been brought about primarily by the needs of the large population center existing in Los Angeles and Orange Counties.

The historic development of irrigation is depicted graphically on Plate 8, "Historic Change in Pattern of Land Use in Orange County Coastal Plain Area". Irrigation development reached a peak in the late 1920's. The historic growth and subsequent decline in irrigated acreage in the Orange County Coastal Plain Unit based on results of land use surveys recorded in 1888, 1909, 1926, 1932, 1942, 1948, and 1957 are presented in Table 3. Also shown are data on urban and suburban land use which data will be discussed in a later section of this report.

TABLE 3

HISTORIC LAND USE
COASTAL PLAIN UNIT, ORANGE COUNTY

Gross Area in Acres

Year	: Irrigated agricultural	: Urban and suburban	: Total
1888	23,500	2,100	25,600
1904	30,700	2,700	33,400
1926	137,900	11,000	148,900
1932	126,500	14,400	140,900
1942	131,200	15,300	146,500
1948	125,700	20,900	146,600
1957	94,700	58,800	153,500

The gross area of the Coastal Plain Unit comprises about 339,000 acres of which 302,000 acres are classified habitable. The remaining 37,000 acres which have been classified as essentially nonhabitable are for the most part within the boundaries of the Cleveland National Forest.

Urban and Suburban Development

Although Orange County is still primarily an agricultural area, the population growth indicates that it is undergoing a rapid transformation toward an urban and suburban area. This transformation has been sharply accelerated in recent years. The growth in residential development may be attributed to a number of causes. These include overcrowding of the urban areas of nearby Los Angeles, an expanded freeway system which makes the suburbs more accessible to that City, the availability of flat land for economical subdivision, and a basic desire for home ownership. In addition, the decentralization of industrial and commercial centers from nearby Los Angeles toward Orange County has created convenient shopping and employment opportunities in this County.

With the expansion of urban population in Orange County there has been a significant increase in industrial development. Major industries from all over the United States, attracted by the mild climate, ability to maintain year-round production, excellent transportation facilities, and ready markets for manufactured goods, have established branch factories, assembly plants and distributorships in the southern California area. An increased proportion of this industry has located in Orange County during recent years, attracted by a relatively abundant labor pool and the availability of land.

Water Supply

The two primary sources of water supply for Orange County are ground water and imported water from the Colorado River through facilities of The Metropolitan Water District of Southern California. As previously mentioned, surface diversions from the Santa Ana River constituted the primary source of

water supply for early irrigation enterprises. However, because of the erratic nature of this supply and increased demands for irrigation and domestic water supplies, this source became inadequate, and wells were drilled to tap the underlying aquifers. As a result of the increased ground water development, large overdrafts have developed in certain portions of Orange County.

The first published engineering evaluation of overdraft conditions was presented in a report entitled "Present Overdraft on, and Safe Yield from, the Ground Water of the Coastal Plain of Orange County", dated June 1, 1945, by the former State Division of Water Resources. At that time, the average annual overdraft on the Coastal Plain was estimated to be 12,000 acre-feet. Subsequent to that date, overdraft continued to increase in magnitude with increased use until about 1950, when the spreading of imported Colorado River water in and adjacent to the bed of the Santa Ana River had a significant effect on the ground water supply.

As a result of the continued overdraft, sea-water intrusion has occurred along portions of the coast line between Newport Harbor and the Los Angeles County line and is imputed to have occurred along other portions of the coast line. At one point on the coast, the line representing 500 parts per million chloride ion has now moved as far as three miles inland. This represents an inland movement of 8,000 feet within the last five years.

In recognition of the inadequacy of local water supplies to meet the growing needs of the County, three cities, Santa Ana, Fullerton, and Anaheim became charter member agencies of The Metropolitan Water District of Southern California. Since the District's organization in 1928, two additional agencies, the Coastal Municipal Water District and the Orange County Municipal Water District were formed and accepted into membership.

Imported water was first delivered to Orange County in 1941 by The Metropolitan Water District of Southern California through the Orange County Feeder. With the exception of the 1954-55 and 1955-56 seasons, when deliveries were temporarily reduced because of insufficient aqueduct capacity, imports have continued to increase. During the 1956-57 season, 154,200 acre-feet of water, 22 per cent of which was softened water, were purchased by Orange County water agencies. The foregoing total amount represents an increase of 370 per cent since 1948. About 900 acre-feet of the water imported is accounted for by increased storage in Santiago Reservoir.

Table 4 gives a tabulation of historic seasonal deliveries of imported water to Orange County. These data are depicted graphically on Plate 6, "Historic Importations of Water into Orange County". Names of water service agencies in Orange County, together with the area irrigated or the number of services maintained are listed in Appendix A.

TABLE 4

HISTORIC SEASONAL DELIVERIES OF IMPORTED WATER TO
ORANGE COUNTY BY THE METROPOLITAN WATER DISTRICT OF
SOUTHERN CALIFORNIA

In Acre-feet

Season ending September 30	: Softened water	: Unsoftened water	: Total delivered
1940-41	1,500	--	1,500
41-42	800	--	800
42-43	700	--	700
43-44	4,300	--	4,300
44-45	9,200	--	9,200
1945-46	10,900	--	10,900
46-47	11,000	--	11,000
47-48	12,300	--	12,300
48-49	12,900	4,700	17,600
49-50	13,200	25,300	38,500
1950-51	15,000	28,500	43,500
51-52	17,500	38,200	55,700
52-53	18,600	28,900	47,500
53-54	22,000	61,000	83,000
54-55	26,500	52,400	78,900
1955-56	28,000	21,700	49,700
56-57	34,600	119,600*	154,200*

* Includes 900 A.F. accounted for by increased
storage in Santiago Reservoir.

The Metropolitan Water District of Southern California is presently engaged in an aqueduct expansion program designed to complete the facilities necessary to import to the South Coastal area annually, the full 1,212,000 acre-feet entitlement to Colorado River water. The initial construction program, completed in 1939, provided tunnels, canals, and conduits sized to carry the entire flow, but provided only one of the two barrels required for each siphon together with an initial pumping capacity of 600 cubic feet per second through three pumps at each of five stations. In 1956, the capacity of the aqueduct was increased from 600 cubic-feet per second to 1,000 cubic-feet per second through the installation of additional pumps. Construction of the remaining siphons and the installation of the remaining pumps is now under way.

In addition to work on the main aqueduct, The Metropolitan Water District of Southern California continued expansion of its distribution system during 1956 and 1957. Additions to the Lower Feeder included 0.8 miles of the line extending westerly from a point 18.5 miles west of Lake Mathews to the Santiago lateral turnout, as well as the Santiago lateral which extends 8.8 miles south to Santiago Reservoir. This extension of the feeder, completed in 1956, has made possible the delivery of unsoftened Colorado River water to the Santa Ana River within Orange County for replenishment of the County's depleted ground water basins. A second portion of the Lower Feeder extending from South Gate easterly into Orange County increased, by approximately 50 per cent, the quantity of softened water available to Orange County users. This eased a shortage which had existed for several years and which had become critical by the fall of 1956. Plans for construction of the intervening section across the northern part of the county are being prepared.

Orange County is currently importing a quantity of water considerably in excess of its theoretical entitlement to Colorado River water. This entitlement has been estimated by the Orange County Water District to be on the order of 80,000 to 90,000 acre-feet annually. This excess import is due in part to the present plan of the Orange County Water District for eliminating ground water overdraft. This plan consists of the purchasing and spreading annually of an amount of Colorado River water equal to the estimated current yearly overdraft, plus an additional amount of water estimated to be sufficient to eliminate the accumulated historic overdraft in a period of 10 to 20 years. Purchase of this water is financed through a combination of pumping assessments and ad valorem taxes. During the 1956-57 water year, 154,200 acre-feet of Colorado River water were imported into Coastal Orange County. Of this amount, 102,400 acre-feet were spread for artificial replenishment purposes.

Continued growth of the county's agriculture, urban areas, and industry is becoming more and more dependent upon an adequate supply of supplemental water which must be imported. In the not too distant future, member agencies of The Metropolitan Water District of Southern California will require additional sources of imported water to supplement the limited Colorado River supplies.

In addition to its program for purchasing imported water for replenishment of its ground water basins, the Orange County Water District has taken legal action to protect the rights of its inhabitants to that portion of its local supply which is derived from ground water basins of the Upper Santa Ana River Valley. In a suit filed in October, 1951, in the Superior Court of San Bernardino County, entitled "Orange County Water

District vs. the City of Riverside, City of Colton, City of San Bernardino and City of Redlands", the Orange County Water District, as the plaintiff, requested the court to enjoin the defendant Cities from pumping water in excess of their rights from the ground water basins of the Upper Santa Ana River Valley and to define these legal rights. In 1957, a memorandum decision handed down by Superior Judge Albert R. Ross ruled in favor of the plaintiff District. His ruling set the legal rights of each of the defendant Cities to water originating in the basins at the highest total quantity of water which each city had continuously produced from its facilities and sources of supply in each of five consecutive years preceding the filing of the complaint. The defendant Cities have filed an appeal in this case.

Sewage and Industrial Waste Disposal

In the early stages of urbanization of Orange County, sewage and waste disposal was accomplished through use of privately-owned cesspools and septic tanks. In free ground water areas, percolation from these cesspools and septic tanks constituted an important source of replenishment to the underlying ground water basins. With increased urban and industrial development it has become necessary to construct extensive sewerage systems and treatment facilities with ocean disposal in the interest of public health and convenience. The installation of these sewerage systems serving urbanized areas overlying free ground water basins is more satisfactory from economic and sanitary points of view. Where the waste waters are of reasonable quality, such works exert an adverse effect on the ground water by removing an important source of replenishment. At present only limited quantities of the treated effluent are returned to ground water by artificial

means. Waste waters of undesirable quality such as may be derived from some industrial processes must be removed from the area to prevent pollution of the ground waters.

Since 1924, treated sewage has been discharged directly to the ocean and tidal lagoons by the County Sanitation Districts of Orange County and their predecessor agencies. More recently, the Cities of Laguna Beach, Seal Beach, and other smaller coastal cities and agencies have commenced discharging increasing amounts of sewage to the ocean.

During the 1956-57 season, a total of 38,900 acre-feet of treated effluent were discharged to the ocean, of which 93 per cent was discharged by the County Sanitation Districts of Orange County. Studies by the Department of Water Resources indicate that approximately 51 per cent of the effluent discharged to the ocean by the Orange County Sanitation Districts originates in free ground water areas of the Coastal Plain and La Habra Units where recharge would be possible.

Presented in Table 5 is a tabulation of quantities of sewage and industrial waste discharged to the ocean from Orange County sewerage systems. Comparative relationships of seasonal sewage and industrial waste discharges to the ocean from the treatment plants of the Orange County Sanitation Districts and from other areas of Orange County are illustrated on Plate 7, entitled "Historical Discharge of Sewage and Industrial Waste to Ocean from Orange County".

TABLE 5

HISTORIC SEASONAL DISCHARGE OF SEWAGE AND INDUSTRIAL WASTE
TO OCEAN FROM ORANGE COUNTY

In Acre-Feet

	Cities in Coastal Plain				Sewered portion of San Juan	
Season ending Sept. 30:	County Sanitation	Seal Beach, Los Alamitos Naval Air Station, Naval Ammunition and Net Depot,	Subtotals for Coastal Plain		Basin, Laguna Beach, South Laguna, Capistrano Beach, Capistrano Palisades, San Clemente, Dana Point, and Doheny State Park	Totals
1928-29	5,947	---	5,947	---	---	5,947
29-30	6,259	---	6,259	---	---	6,259
1930-31	5,915	---	5,915	---	---	5,915
31-32	6,245	---	6,245	---	---	6,245
32-33	5,778	---	5,778	---	---	5,778
33-34	5,786	---	5,786	---	---	5,786
34-35	6,230	---	6,230	---	---	6,230
1935-36	6,810	---	6,810	560	560	7,370
36-37	7,789	---	7,789	565	565	8,354
37-38	7,624	---	7,624	570	570	8,194
38-39	7,509	---	7,509	575	575	8,084
39-40	7,924	---	7,924	580	580	8,504
1940-41	8,754	---	8,754	629	629	9,383
41-42	8,804	---	8,804	676	676	9,480
42-43	9,539	---	9,539	718	718	10,257
43-44	10,253	---	10,253	757	757	11,010
44-45	11,205	---	11,205	796	796	12,001

HISTORIC SEASONAL DISCHARGE OF SEWAGE AND INDUSTRIAL WASTE
TO OCEAN FROM ORANGE COUNTY
(continued)

Season ending : Sept. 30:	Cities in Coastal Plain			Sewered portion of San Juan		
	County Sanitation :	Seal Beach, Los Alamitos Naval Air Station, Naval Ammunition and Net Depot :	Subtotals for Coastal Plain :	Basin, Laguna Beach, South Laguna, Capistrano Beach, Capistrano Palisades, San Clemente, Dana Point, and Doheny State Park :	Totals	
1945-46	11,480	192	11,672	839	12,511	
46-47	11,840	219	12,059	882	12,941	
47-48	12,350	368 ^a	12,718	925	13,643	
48-49	13,686	394 ^a	14,080	976	15,056	
49-50	14,756	299	15,055	1,030	16,085	
1950-51	16,346	324	16,670	1,096	17,766	
51-52	17,993	364	18,357	1,206	19,563	
52-53	19,057	392	19,449	1,434	20,883	
53-54	21,025	499	21,524	1,579	23,103	
54-55	25,442	505	25,947	1,542	27,489	
1955-56	32,637	579	33,216	1,745	34,961	
56-57	39,784	818 ^b	40,607	1,708	42,315	

a. Includes 122 acre-feet per year estimated flow from Sunset Beach.

b. Includes 196 acre-feet per year estimated flow from Sunset Beach.

Not included in Table 5 is the amount of reclaimed water purchased from the County Sanitation Districts of Orange County by the Talbert Water District for irrigation purposes. The water is applied to approximately 2,000 acres located just west of the Santa Ana River and adjacent to the coast. This diversion, which began in December, 1956, amounted to about 2,160 acre-feet during the 1956-57 water year.

CHAPTER II LAND USE

The nature, location, and areal extent of present land use within the Orange County Area was determined by a detailed land use survey conducted during the summer of 1957. Results of that survey are presented in this chapter, together with discussion and tabulations of land use within the various hydrologic units of the investigational area.

Methods and Procedures

The survey of land use within the Orange County Area was carried out by the use of methods and procedures similar to those utilized in the 1948 survey. Those procedures are described in Chapter II, State Water Resources Board Bulletin No. 2. The only change in the procedures used in the 1957 survey was in the classification of certain specified types of land use. For example, schools which were included in "unclassified urban and suburban areas" in 1948 were classified as "commercial" in 1957.

For the most part field mapping of land use in connection with the current investigation was carried on during the summer of 1957. In addition, three supplemental surveys at three-month intervals were conducted in areas subject to multiple cropping in an endeavor to determine the degree of such usage.

Mapping in the field was expedited by the use of recent aerial photographs of the entire investigational area, supplemented by the use of United States Geological Survey 7 1/2 minute quadrangle maps.

The grouping of land use categories for survey purposes was based primarily on relative water-using characteristics. Inasmuch as

this survey was designed for both determination of present net water use and hydrologic analysis of the basin, all categories of land use were mapped in areas overlying defined ground water basins. In areas tributary to defined ground water basins, only those categories requiring applied water were mapped, since such categories must be served either from water exported from the defined ground water basin or by additional import to the watershed. Other categories in the tributary areas did not require detailed mapping since only runoff from these areas is required in the aforementioned analysis. This runoff inherently includes deductions for consumptive use.

Delineation of urban and agricultural lands was made on the basis of their gross areas. Thus, in general, the included areas of streets, roads, railroads, and power line rights of way were not segregated at the time of the survey. These items were later evaluated and net areas obtained by application of appropriate percentage factors to the gross surveyed areas. These factors, which are listed in Table 6, were determined from detailed surveys of representative sample plots.

TABLE 6
FACTORS FOR CONVERSION FROM GROSS
TO NET WATER SERVICE AREAS

Classification	: Percent Deducted : from Gross Area
Residential	25
Commercial	35
Industrial Manufacturing	25
Parks, cemeteries, and golf courses	15
Farmsteads, feedlots, dairies	10
Irrigated Agriculture	5

Categories of Land Use

For purposes of analysis and presentation herein, the various types of land use were combined into several general categories. The specific types of land use included in each of these categories is as follows:

WATER SERVICE AREAS

URBAN AND SUBURBAN

- Residential Single and multiple family houses and apartments, rest homes, trailer parks, and residential subdivisions under construction at time of survey.
- Commercial All classes of commercial enterprises, including strip commercial and downtown commercial areas, schools, and hospitals.
- Industrial All classes of industrial land use involving manufacturing, processing, and packaging, excluding extractive (oil, sand and gravel), storage and distribution industries, transportation facilities and air-fields.
- Unclassified Urban
and Suburban Areas Dairies, farmsteads, live stock ranches, parks, cemeteries and golf courses.
- Included Nonwater
Service Areas Oil fields, tank farms, vacant lots, quarries, gravel pits, warehouses and storage yards, railroads, public streets, and landing strips of air-fields.

IRRIGATED AGRICULTURE

- Alfalfa Hay, seed and pasture.
- Pasture Irrigated grasses and legumes other than alfalfa used for livestock forage.

Citrus and Subtropical	Oranges, lemons, grapefruit, tangerines, and avocados.
Truck Crops	Fresh vegetables of all varieties, flower seed, and nursery crops.
Field Crops	Lima beans, dry field beans, sugar beets, field corn and hops.
Deciduous and Nuts	All varieties of deciduous fruits, olives, and nuts.
Small Grain	Barley, wheat, oats, and rye.
Vineyards	
Included Nonwater Service Areas	Public highways and roads, farm access roads, and other inclusions not devoted to crop production.

NONWATER SERVICE AREAS

<u>NON IRRIGATED AGRICULTURE</u>	All varieties of dry-farmed crops, including pasture overlying defined ground water basins.
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<u>NATIVE VEGETATION</u>	Native grasses, brush, and trees, including phreatophytes overlying defined ground water basins.
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<u>UNCLASSIFIED</u>	Bare ground, including river washes, beaches, and water surfaces overlying defined ground water basins. It also includes nonirrigated agriculture and native vegetation not overlying defined ground water basins and may include minor isolated recreation areas.
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Results of Land Use Survey

Data obtained from this survey have been compiled in Tables No. 7, 8, and 9 which summarize the land use for the hydrologic units previously described. Comparable land use data from the 1948 survey are also presented. The results of the 1957 survey are illustrated graphically by the color

separations on Plate 9, "Present Land Use in Orange County". In the preparation of this plate no differentiation was made between areas devoted to native vegetation and areas such as nonirrigated agricultural lands which are developed but do not require water service.

TABLE 7

1957 LAND USE IN ORANGE COUNTY,
BY HYDROLOGIC UNITS

In Acres		: Hydrologic Unit :				Totals
Nature and class of land use		La Habra :	Coastal : Plain :	San Juan : Capistrano :		
WATER SERVICE AREAS						
<u>Urban and Suburban</u>						
Residential	1,824	24,819	1,315		27,958	
Commercial	209	3,186	248		3,643	
Industrial	67	1,350	34		1,451	
Unclassified urban and suburban areas	126	5,517	433		6,086	
Subtotals	2,226	34,872	2,030		39,138	
Included Nonwater Service Areas	3,929	23,976	2,142		30,047	
Gross Urban and Suburban Areas	6,155	58,848	4,172		69,185	
<u>Irrigated Agriculture</u>						
Alfalfa	--	2,297	150		2,447	
Pasture	239	3,772	63		4,074	
Citrus and subtropical	2,812	43,161	2,499		48,472	
Tree crops	141	19,315	872		20,328	
Field crops	--	19,657	--		19,657	
Deciduous and mts	20	1,014	2		1,036	
Small grain	56	717	--		773	
Vineyards	--	25	--		25	
Subtotals	3,268	89,968	3,586		96,822	
Included Nonwater Service Areas	172	4,738	189		5,099	
Gross Irrigated Agricultural Areas	3,440	94,706	3,775		101,921	
GROSS WATER SERVICE AREAS	9,602	153,554	8,247		171,406	
<u>NONWATER SERVICE AREAS</u>						
<u>Nonirrigated Agriculture</u>						
Native Vegetation	3,926	36,724	5,334		45,984	
Unclassified	1,804	20,905	4,150		26,859	
	2,678	128,083	152,597		283,360	
GROSS NONWATER SERVICE AREAS	8,411	185,712	162,081		356,201	
TOTALS	18,013	339,266	170,328		527,607	

TABLE 8

1948 LAND USE IN ORANGE COUNTY
BY HYDROLOGIC UNITS

In Acres

Nature and class of land use	Hydrologic Unit				Total 1948	Total 1957
	La Habra	Coastal	San Juan	Capistrano		
WATER SERVICE AREAS						
Urban and Suburban						
Residential	568	9,559	1,588		11,715	27,958
Commercial	100	2,756	--		2,856	3,643
Industrial	24	540	--		564	1,451
Unclassified urban and suburban areas	28	73	129		230	6,086
Subtotals	720	12,928	1,717		15,365	39,138
Included Nonwater Service Areas	4,013	8,015	680		12,708	30,247
Gross Urban and Suburban Areas	4,733	20,943	2,397		28,073	69,485
Irrigated Agriculture						
Alfalfa	--	5,569	264		5,833	2,447
Pasture	64	3,406	105		3,575	4,074
Citrus and subtropical	5,938	64,529	2,880		73,347	48,472
Truck crops	22	16,213	443		16,678	20,328
Field crops	58	26,742	161		26,961	19,667
Deciduous and nuts	95	2,323	149		2,567	1,036
Small grain	90	547	16		653	773
Miscellaneous	--	--	--		--	25
Subtotals	6,267	119,329	4,018		129,614	96,822
Included Nonwater Service Areas	330	6,287	390		7,007	5,092
Gross Irrigated Agriculture Areas	6,597	125,616	4,408		136,621	101,921
GROSS WATER SERVICE AREAS	11,330	146,559	6,805		164,694	171,406
GROSS NONWATER SERVICE AREAS	6,683	192,707	163,523		362,913	356,201
TOTALS	18,013	339,266	170,328		527,607	527,607

Inspection of Table 8 shows that during the nine year period from 1948 through 1957, the gross water service area of Orange County increased from 164,700 acres to 171,400 acres, an increase of about four per cent. In 1957 about 35 per cent of the land classified as habitable in the County was receiving water service. During the period between 1948 and 1957 the gross urban and suburban area increased by 41,400 acres while the gross irrigated agricultural area decreased by 34,700 acres. This indicates a substantial urban and suburban development of formerly agricultural lands. Land lost to agriculture was for the most part citrus and subtropical acreage, which, during this period, was reduced by 24,900 acres or nearly 35 per cent. The largest increase in urban and suburban acreage was in residential development which increased from 11,700 acres to about 28,000 acres or about 140 per cent. In addition, industrial development increased from 560 to 1,450 acres, or about 160 per cent. During the same period, land devoted to farmsteads, dairies, livestock, ranches, parks, and cemeteries as tabulated under unclassified urban and suburban areas increased from 230 acres in 1948 to 6,086 acres in 1957, an increase of over 2,500 per cent.

The areal change in land use in Orange County during the period from 1948 to 1957 is demonstrated graphically on Plate 10, "Change in Land Use, 1948-1957". The plate shows the areas where urban-suburban and irrigated agricultural development has occurred.

La Habra Unit

The gross urban and suburban area in the La Habra Unit increased by about 1,400 acres, while the gross irrigated agricultural area decreased by about 3,100 acres. Thus, during this period the gross water service area



Santa Ana
Industrial
Area
July, 1947

Spence Air Photos

Courtesy Spence Air Photos



Santa Ana
Industrial
Area
June, 1958

SPENCE
Air Photos

decreased by about 1,700 acres. The net loss in gross water service area is believed to be the result of removal of acreage, primarily citrus orchards, from cultivation pending subdivision development. Citrus acreage in the La Habra Unit has decreased by over 50 per cent from 5,900 acres to 2,800 acres.

Coastal Plain Unit

The Coastal Plain Unit experienced a net increase of about 7,000 acres in gross water service area between 1948 and 1957. This increase in gross water service area was the result of a decrease in the gross irrigated agricultural area of nearly 30,900 acres coupled with an expansion in gross urban and suburban area of about 37,900 acres.

The rise in urban and suburban acreage was due in large part to an increase in acreage devoted to all types of residential development from 9,600 acres in 1948 to 24,800 acres in 1957. At the same time unclassified urban and suburban acreage increased from less than 100 acres to over 5,500 acres.

The decline in agricultural acreage was manifested primarily in a reduction of land used for citrus and subtropical agriculture from 64,500 acres in 1948 to 43,200 in 1957. This represents a decrease of approximately 33 per cent.

The encroachment of urban and suburban development upon irrigated lands and habitable nonwater service lands is depicted graphically on Plate 8. The area of habitable nonwater service lands indicated thereon was determined from land classification surveys conducted for State Water Resources Board Bulletin No. 2. As previously mentioned the

nonhabitable land indicated thereon is comprised primarily of the Cleveland National Forest.

San Juan Capistrano Unit

The San Juan Capistrano Unit, as defined herein, comprises about 170,300 acres. The gross water service area includes about 8,200 acres or approximately 5 per cent of the total area, and includes about 1,450 acres more than in 1948. The gross urban and suburban area has increased from 2,400 acres in 1948 to 4,500 acres in 1957. This development is generally located along the coast in the seaside resort cities.

Special Resurvey of Multiple Crop Areas

As stated, three supplementary surveys of multiple crop areas were conducted in an endeavor to ascertain the pattern of plantings practiced by farmers on the Coastal Plain of Orange County. These surveys were conducted in December, 1957, February, 1958, and May, 1958. The area encompassed by the resurvey comprised about 20,000 acres. This included about 5,100 acres indicated to be fallow at the time of the original survey in August, 1957. The detailed results of this resurvey are presented in Table 9, "Special Resurvey of Multiple Crop Areas on Coastal Plain of Orange County".

TABLE 9

SPECIAL SURVEY OF MULTIPLE CROP AREAS ON COASTAL PLAIN OF ORANGE COUNTY

Gross Area in Acres

Crop	Date of Survey			
	August 1957	December 1957	February 1958	May 1958
Asparagus	992	317	317	317
Beans (green)	3,948	631	474	2,094
Broccoli, cabbage, cauliflower	373	1,128	422	173
Corn, green	420	40	31	333
Carrots	47	0	266	182
Celery	304	787	624	384
Lettuce and romaine	105	1,163	472	93
Melons, squash, cucumbers	306	25	0	342
Onion and garlic	62	122	0	7
Peas	123	0	173	584
Potatoes	33	0	0	12
Sweet potatoes	2,552	1,132	0	2,075
Spinach	9	0	814	0
Tomatoes	3,505	0	0	1,754
Flowers and nursery	86	39	35	72
Miscellaneous truck	2,083	700	1,311	1,590
Strawberries	0	289	356	577
Peppers (chile, bell, etc.)	0	110	0	0
Fallow	5,127	13,019	13,804	7,248
Subtotal Truck Crops	20,075	19,502	19,099	17,837
Field Crop	0	573	976	2,238
Totals	20,075	20,075	20,075	20,075

The results of this survey indicate an interesting pattern of multiple plantings. For example, during the months of August and May, the emphasis in truck crops was to green beans, asparagus, sweet potatoes, and tomatoes, while during December the emphasis was more on leaf vegetables, such as broccoli, lettuce, and celery. In February the predominate crops were celery and spinach. It will be noted that in the period between August, 1957, and May, 1958, there was an increasing amount of truck acreage planted to field crops, usually field beans, such as dry lima beans and kidney beans. Based on studies from this special survey, it is estimated that multiple crop areas are normally planted to irrigated crops approximately 46 per cent of the time, and that during the remaining periods these areas are in fallow or are planted to nonirrigated field crops. Unit values of applied water, as derived in Chapter III, were therefore applied to 46 per cent of the truck crop acreage shown in Tables 7 and 8.

CHAPTER III NET WATER USE

Population growth and the resulting change in land use have had a noticeable effect on the net water use of the Orange County Area. During the period between 1950 and July, 1957, population in the area increased about 304,000. The changes in land use between 1948 and 1957 resulted in a gross increase in the water service area of about 6,700 acres. This increase in water service area and other factors discussed in this chapter resulted in an increase in the net water use of about 8,100 acre-feet per year in the Orange County Area.

Unit Values of Water Use

A review of unit values of water use derived in State Water Resources Board Bulletin No. 2 was made in order to determine the applicability of these unit values to 1957 conditions of development. Detailed studies of water use in sample industrial areas were conducted to supplement other available data. Results of these studies indicated that, for the most part, mean seasonal unit values of water use derived in 1948 were still applicable in 1957. However, mean seasonal unit values of applied water for industrial manufacturing purposes have apparently increased from 9.2 to 10.8 acre-feet per acre. A complete discussion of the techniques employed in the derivation of unit values is contained in Chapter II of State Water Resources Board Bulletin No. 2, and, therefore, only a general description of those procedures is set forth herein.

In general, unit values of consumptive use of applied water for each of the irrigated crop classes were estimated by a modification of a

method developed by Harry F. Blaney and Wayne D. Criddle of the United States Department of Agriculture. The Blaney-Criddle Method was outlined in reports of the United States Department of Agriculture, entitled "A Method of Estimating Water Requirements in Irrigated Areas from Climatological Data", dated December, 1947, and "Determining Water Requirements in Irrigated Areas from Climatological Data", dated August, 1950. The technique involves correlation and adjustment of available data on consumptive use of water for irrigated crops in other localities in accordance with experimental data and environmental conditions prevailing in the Orange County Area. Mean seasonal unit values of applied water for the various irrigated crop classes were assumed to be equal to the respective derived unit values of consumptive use of applied water divided by the estimated crop irrigation efficiency. Available field data indicate that an average irrigation efficiency of about 70 per cent is being achieved for most crops in the Orange County Area, and this figure was utilized in the current investigation.

Mean seasonal unit values of water use on urban and suburban lands were estimated on the basis of a sampling procedure in which an inventory was made of measured water deliveries to sample areas representative of each category of land use. In the case of residential and commercial areas, a series of sample areas consisting of single blocks wholly devoted to one type of land use were chosen. Unit values of applied water were computed by dividing the amount of water delivered to a sample area by the net sampled area.

With respect to the review of unit values of water use for manufacturing purposes, a total of 33 industries were canvassed. These industries included meat packing plants, refineries, vegetable and fruit processing plants, glass, pottery and tile industries, and miscellaneous metal assembly and other

manufacturing plants. The average depth of applied water over the composite industrial acreage sampled was nearly 20 feet per year. When weighted according to the distribution of industries encountered in the land use survey, the average unit value of industrial water was determined to be about 10.8 acre-feet per acre. This figure was assumed to be representative of the unit value of applied water for industry in Orange County under 1957 conditions of development. It represents a 17 per cent increase over the mean seasonal unit value of 9.2 acre-feet per acre adopted for the earlier state-wide studies and for the Los Angeles Metropolitan Area, including Orange County.

Mean seasonal unit values of water use applied in the derivation of 1957 net water use for Orange County are presented in Tables 10 and 11. Table 10 contains estimated mean seasonal unit values of consumptive use of water on irrigated lands, and Table 11 contains estimated mean seasonal unit values of applied water, labeled "Total Applied Water", and consumptive use of water on urban and suburban lands.

TABLE 10

ESTIMATED MEAN SEASONAL UNIT VALUES
OF CONSUMPTIVE USE OF WATER ON IRRIGATED LANDS,
ORANGE COUNTY

In feet of depth

Type of Land Use	H y d r o l o g i c U n i t								
	La Habra			Coastal			San Juan Capistrano		
	:Applied:	Precipi-:	:Total:	:Applied:	Precipi-:	:Total:	:Applied:	Precipi-:	:Total:
	water	tation		water	tation		water	tation	
Alfalfa	2.4	1.1	3.5	2.4	1.1	3.5	2.4	1.2	3.6
Pasture	2.4	1.1	3.5	2.4	1.1	3.5	2.5	1.1	3.6
Deciduous & Nuts	1.7	1.1	2.8	1.7	1.1	2.8	1.5	1.2	2.7
Citrus	1.3	1.1	2.4	1.3	1.1	2.4	1.4	1.1	2.5
Truck crops	1.3	0.9	2.2	1.3	0.9	2.2	1.4	0.7	2.1
Field	1.3	0.9	2.2	1.3	0.9	2.2	1.3	0.7	2.0
Small grain	0.7	1.0	1.7	0.7	1.0	1.7	0.4	1.2	1.6
Miscel- laneous	1.3	0.9	2.2	1.3	0.9	2.2	1.3	0.8	2.1
Streets & roads	---	0.5	0.5	---	0.5	0.5	---	0.5	0.5

ESTIMATED MEAN SEASONAL UNIT VALUES OF APPLIED WATER
AND CONSUMPTIVE USE OF WATER BY URBAN AND SUBURBAN LANDS
IN ORANGE COUNTY

In feet of depth

Type of land use	H y d r o l o g i c U n i t											
	San Juan Capistrano				La Habra				Coastal			
	Consumptive use		Total		Consumptive use		Total		Consumptive use		Total	
	Applied:	Precipitation:	Applied:	water:	Applied:	Precipitation:	Applied:	water:	Applied:	Precipitation:	Applied:	water:
Residential - Single	1.3	0.9	2.2	2.8	1.3	0.9	2.2	2.6	1.3	0.9	2.2	2.6
Residential - Multiple	0.3	0.6	0.9	5.0	0.3	0.6	0.9	4.5	0.3	0.6	0.9	4.5
Residential - Estate	1.5	1.1	2.6	2.2	1.5	1.1	2.6	2.0	1.5	1.1	2.6	2.0
Farmsteads	0.8	0.8	1.6	1.8	0.8	0.8	1.6	1.8	0.8	0.8	1.6	1.8
Commercial - Strip	0.4	0.5	0.9	4.0	0.4	0.5	0.9	3.4	0.4	0.5	0.9	3.4
Commercial - Downtown	1.1	0.5	1.6	10.2	1.1	0.5	1.6	10.2	1.1	0.5	1.6	10.2
Industrial - Manufacturing	1.4	0.6	2.0	10.8	1.4	0.6	2.0	10.8	1.4	0.6	2.0	10.8
Schools	0.4	0.7	1.1	1.1	0.4	0.7	1.1	0.9	0.4	0.7	1.1	0.9
Dairies	1.0	0.9	1.9	1.9	1.0	0.9	1.9	1.9	1.0	0.9	1.9	1.9

ESTIMATED MEAN SEASONAL UNIT VALUES OF APPLIED WATER
AND CONSUMPTIVE USE OF WATER BY URBAN AND SUBURBAN LANDS
IN ORANGE COUNTY
(continued)

In feet of depth

Type of land use	H y d r o l o g i c U n i t											
	San Juan Capistrano						La Habra					
	Consumptive use			Total			Consumptive use			Total		
	Applied	Precipitation	water	Applied	Precipitation	water	Applied	Precipitation	water	Applied	Precipitation	water
Livestock and Poultry ranches	0.6	0.7	1.3	1.3	0.6	0.7	1.3	0.6	0.7	1.3	0.6	1.3
Trailer parks	0.5	0.5	1.0	1.0	0.5	0.5	1.0	0.5	0.5	1.0	0.5	1.0
Industrial - Extractive	---	0.6	0.6	---	---	0.6	0.6	0.6	---	---	0.6	---
Subdivided	---	0.6	0.6	---	---	0.6	0.6	0.6	---	---	0.6	---
Airports	---	0.5	0.5	---	---	0.5	0.5	0.5	---	---	0.5	---
Vacant	---	0.6	0.6	---	---	0.6	0.6	0.6	---	---	0.6	---
Streets and roads	---	0.5	0.5	---	---	0.5	0.5	0.5	---	---	0.5	---

Present Net Water Use

The present net water use in Orange County was determined by applying unit values of either applied water or consumptive use to the net areas of each type of land use category determined during the current investigation. In the derivation of the net water use, consideration was given to the disposition of the unconsumed portion of the applied water with regard to its availability for re-use, and to losses incurred in conveyance of water to its place of use.

In water service areas overlying, or tributary, to free ground water basins it was assumed that all applied water in excess of consumptive use requirements, except the sewage and industrial waste which is exported from the area, returns to the underlying ground water storage and is available for re-use. The net water use for these areas was, therefore, estimated to be the sum of the consumptive use of applied water and sewage export. In those water service areas overlying, or tributary, to confined ground water basins or in areas adjacent to the ocean, it was assumed that no re-use of applied water in excess of consumptive use could be effected. In these areas the net water use was assumed to be equal to the total applied water.

Net water use in a particular area is determined to a large degree by the interrelated topographic, geologic, and other physical conditions affecting the use and re-use of water. In this regard, the available local water supplies during the period between 1929 and 1957 have been reduced more and more each year by the extension of sewerage facilities connected to ocean outfalls into lands overlying free ground water

basins. The necessary export of sewage from these areas has removed an important source of replenishment to those basins.

Table 12 presents the estimated mean seasonal net water use in hydrologic units of the Orange County Area for conditions of 1957. For comparative purposes, Table 13 presents the estimated mean seasonal net water use in the same hydrologic units for 1948 conditions.

TABLE 12
ESTIMATED 1957 MEAN SEASONAL NET WATER
USE IN ORANGE COUNTY

In acre-feet

Hydrologic Unit	Irrigated lands	Urban and suburban areas	Total
La Habra	4,400	99,300 ^a	234,600 ^b
Coastal Plain	130,900		
San Juan Capistrano	4,600	4,800	9,400
	<u>139,900</u>	<u>104,100</u>	<u>244,000</u>

a. Sewage outflow from La Habra Unit and nonpressure portion of the Coastal Plain Unit combined.

b. Mean seasonal net water use for La Habra Unit and Coastal Plain Unit combined.

TABLE 13

ESTIMATED 1948 MEAN SEASONAL NET WATER
USE IN ORANGE COUNTY

In acre-feet

Hydrologic Unit	Irrigated lands	Urban and suburban areas	Total
La Habra	8,300		
Coastal Plain	183,500	36,700 ^a	228,500 ^b
San Juan Capistrano	<u>4,000</u> 195,800	<u>3,400</u> 40,100	<u>7,400</u> 235,900

a. Sewage outflow from La Habra Unit and nonpressure portion of the Coastal Plain Unit combined.

b. Mean seasonal net water use for La Habra Unit and Coastal Plain Unit combined.

It is estimated that the mean seasonal net water use for Orange County under 1957 conditions was about 244,000 acre-feet. This represents an increase of about 8,100 acre-feet, or three and one-half per cent more than the 235,900 acre-feet of net water use estimated for 1948 conditions. An increase was realized in both the San Juan Capistrano and the combined Coastal Plain - La Habra Units. The largest increase on a percentage basis occurred in the San Juan Capistrano Unit where the seasonal net water use increased an estimated 2,000 acre-feet per year, or more than 25 per cent. However, the largest total gain occurred in the combined La Habra-Coastal Plain Unit where the estimated net water use increased by 6,100 acre-feet. For purposes of derivation of net water use, the La Habra and the Coastal Plain Units were combined, since it was not feasible to differentiate between the sewage flow from the La Habra Unit and the Santa Ana Forebay Area of the Coastal Plain Unit.

With respect to net water use for the La Habra unit, there was a net loss of about 1,700 acres in water service area in this unit between 1948 and 1957. This loss resulted primarily from the removal of acreage from cultivation pending change in use to anticipated subdivision development. For this reason it is believed that substantially all of the increase in net water use indicated for the combined La Habra - Coastal Plain Units occurred in the Coastal Plain Unit. Further, it is possible that there was a decrease in net water use in the La Habra Unit and that the increase in the Coastal Unit was greater than the 6,100 acre-feet indicated for the combined units.

Supplemental Water Requirement

The supplemental water requirement for the Orange County Area for conditions of 1957 was computed as the difference between the 1957 net water use as set forth in Table 12 and the safe yield of local water supplies.

The safe yield of local water supply sources was determined by studies made in connection with the preparation of State Water Resources Board Bulletin No. 2 and State Division of Water Resources Bulletin No. 53. From these studies the mean seasonal safe local yield of the Orange County Area was estimated to be about 153,500 acre-feet. The preparation of this estimate required the approximation that a pro rata share of the safe yield of the La Habra Unit, which covers portions of both Orange and Los Angeles Counties, can be arbitrarily assigned to the La Habra Unit in Orange County.

The net water use determined for each of the land use surveys conducted in the Orange County Area since 1926, together with the supplemental water requirement and the historic import for each survey year are given in Table 14. Also included in Table 14 are the estimated ultimate applied

water requirements for Orange County as derived for State Water Resources Board Bulletin No. 2. The imported supplies do not include water imported to the La Habra Unit from adjacent ground water basins in Los Angeles County. Review of data in the files of the Department of Water Resources indicates this supply was small in magnitude when compared to supplies imported through facilities of The Metropolitan Water District of Southern California subsequent to the 1943-44 water year.

TABLE 14
COMPARISON OF NET WATER USE AND SUPPLEMENTAL
REQUIREMENTS, ORANGE COUNTY

In Acre-feet

Date of survey	Net water use	Safe yield of local supplies	Supplemental water requirements	Historic imports ^a
1926 ^b	240,100	142,500	97,600	0
1932 ^b	234,300	142,500	91,800	0
1942 ^b	230,900	142,500	88,400	700
1948	235,900	153,500	82,400	38,500
1957	244,000	153,500	90,500	154,200
Ultimate Conditions	825,000	153,500	671,500	---

a. From The Metropolitan Water District of Southern California.

b. For Coastal Plain Unit only.

In the computations for the foregoing table, the safe yield of local supplies based upon a mean period is taken as the local supply available. It is not the actual local supply available for that particular

year. For individual years, differences between the actual supply and the mean supply or safe yield are absorbed by change in ground water storage in the normal process of regulation of the erratic water supplies experienced during the wet and dry years.

A review of Table 14 will show that in all years except 1957 net water use exceeded the combination of the safe yield of local supplies plus the imported supply. During periods of deficit supply, the net water use in excess of safe yield was met by overdraft on the accumulated ground water in storage. This is illustrated graphically on Plate 11, "Water Supplies and Estimated Water Utilization, Orange County Coastal Plain". On this plate there is presented a comparison of estimated water supplies and water utilization in Orange County Coastal Plain Unit for historic conditions, insofar as records are available, and for present conditions. Also delineated on this plate is the estimated ultimate applied water requirement for the Orange County Coastal Plain Unit which was presented in State Water Resources Board Bulletin No. 2.

A comparison of data presented in Table 4, "Historic Seasonal Deliveries of Imported Water to Orange County by The Metropolitan Water District of Southern California", with the supplemental water requirements presented in Table 14, and an interpolation of these requirements between survey dates on a straight line basis will show that, with the exception of the water years 1953-54, 1954-55, and 1956-57, the supplemental water requirements substantially exceeded the quantity imported. Thus, it is indicated that an overdraft of substantial magnitude has existed in Orange County for a considerable period of time prior to the 1953-54 water year.

Under ultimate conditions, the estimated total seasonal applied water requirement for the Orange County Area will be about 825,000 acre-feet.

Of this requirement approximately 671,000 acre-feet must be derived by importing supplies from outside Orange County. The increase in net water use between present and ultimate conditions is anticipated to be the result of development of and consequent water service to about 319,300 acres classified as habitable, but not currently receiving water service. Satisfaction of these ultimate net water requirements will require the seasonal importation of between 580,000 and 590,000 acre-feet of water in excess of Orange County's entitlement to Colorado River water, presently estimated at 80,000 to 90,000 acre-feet per year. In view of this and the increased imported supplies which will be required by other areas in southern California under ultimate conditions, it is apparent that Orange County, in conjunction with the other areas, has a great interest in the early importation of water from northern California.

In Chapter I it was stated that, beginning in 1949, the Orange County Water District has purchased Colorado River water, insofar as available, for artificial replenishment of the aquifers of Orange County. The District has attempted to purchase an amount of water equal to the estimated annual overdraft plus an additional quantity to be used to gradually overcome the historic accumulated overdraft. The efforts of this agency have met with increasing success beginning with the year 1953-54, although during the 1955-56 season purchases were curtailed because of temporary limitations on the aqueduct capacity of The Metropolitan Water District of Southern California. During the 1956-57 fiscal year, the Orange County Water District was able to purchase sufficient imported water to replace a portion of the supplies withdrawn from the ground water body to meet the historic overdraft.

The overdraft on ground water supplies in Orange County was manifested primarily in the progressive lowering of ground water levels throughout the area, and in coastal areas by the replacement of fresh water in the pressure aquifers with intruding sea water. The effects of artificial replenishment activities of the Orange County Water District may be seen from an inspection of Plate 12, "Longitudinal Water Level Profiles, Mouth of Santa Ana Canyon to Pacific Ocean", which was adapted from a plate prepared by that agency and presented in "Engineer's Report on Ground Water Conditions in Orange County Water District", dated March, 1958, by Paul Bailey. The profiles of water levels presented on this plate were computed from the average of water surface elevations at wells along lines extending easterly and westerly from the profile. Inspection of this plate will show that between 1956 and 1957 there was, in general, a rise in water levels throughout the Coastal Plain, with rises of much greater magnitude in the upstream forebay or free ground water areas. Studies by the Orange County Water District indicate that ground water levels in Orange County raised an average of about 5 1/2 feet between the fall of 1956 and the fall of 1957, primarily as a result of spreading activities.

Although water levels were raised throughout a large part of the Coastal Plain between the fall of 1956 and the fall of 1957, it should be pointed out that in the areas adjacent to the coast, the trough, or point of minimum water level elevation, remained below sea-level. Furthermore, the position of this trough moved inland approximately one mile to a point about 15,000 feet from the coast. This inland movement indicates some loss of usable ground water storage, since as the position of a trough which is below sea level moves inland, sea water eventually follows with a consequent loss of use of the portion of the aquifer into which sea water has intruded.

This loss cannot be reclaimed until such time as water levels adjacent to the coast are raised above sea level and the sea water is flushed out.

An interesting feature of Plate 12 is that it illustrates the large amount of unwatered storage presently available in the forebay area of the Coastal Plain of Orange County. This storage, utilized to the maximum feasible extent commensurate with the maximum conservation of local supplies, will provide relatively inexpensive regulatory storage for imported supplies. The use of such available storage for regulation of imported water is an integral part of The California Water Plan.

A water conservation program practiced in the Orange County Area is that of the Talbert Water District where water reclaimed from sewage is utilized for irrigation purposes. All reclaimed water thus utilized represents a gain in water supply, since such water would otherwise be discharged to the ocean and the water requirements thus satisfied would have to be met by additional importation.

CHAPTER IV. SUMMARY OF FINDINGS

The results of the 1957 survey of land and water use in Orange County are summarized as follows:

1. During the period from 1950 through July, 1957, the population of the Orange County Area increased from about 216,000 to an estimated 520,000, a growth of about 304,000 or 140 per cent.

2. As a result of population growth, the gross water service area of the Orange County Area increased from 164,700 acres in 1948 to 171,400 acres in 1957, an increase of 6,300 acres or about 4 per cent. The gross urban and suburban area expanded from 28,100 acres in 1948 to 69,500 acres in 1957, an increase of 41,400 acres or about 145 per cent. During the same period the estimated gross irrigated area was reduced from about 136,600 acres to 101,900 acres, a reduction of 34,700 acres or about 25 per cent.

3. The estimated mean seasonal net water use of the Orange County Area increased from 235,900 acre-feet in 1948 to 244,000 acre-feet in 1957, an increase of 8,100 acre-feet or about 3 1/2 per cent.

4. Net water use in the Orange County Area has exceeded the sum of the safe yield of local supplies and imported supplies from a date sometime prior to 1926 until the 1953-54 water year. During this period, demands for water in excess of the sum of the safe yield of local supplies and imported Colorado River water were met by overdraft on the ground water supply. However, as a result of action by the Orange County Water District, Colorado River water was purchased and spread during the 1953-54, 1954-55, and 1956-57 water years in sufficient amounts to approximately balance the items of supply and disposal. Furthermore, during the 1956-57 water

year, sufficient Colorado River water was purchased to replace in storage a portion of the water previously withdrawn by the historic overdraft.

5. Of the total area of 527,600 acres in Orange County, there still remain about 319,300 acres of habitable land upon which there is essentially no water use. As these lands are developed, the net water requirements will increase, reaching a total of about 825,000 acre-feet seasonally with full development of all habitable areas within the county. Of this total, the safe yield of local resources will supply 153,500 acre-feet. The remainder of the ultimate supply must be imported from sources outside of Orange County. A portion of this amount, 80,000 to 90,000 acre-feet seasonally, can be obtained from Orange County's entitlement to Colorado River water.

6. The rapidly changing character of the land use which is currently occurring and will probably continue to occur in Orange County emphasizes the periodic need for the type of survey conducted for this report. This need is based upon the continued requirement for basic data related to items affecting the use of water. These data are the prerequisite to sound water resources planning.

APPENDIX A

WATER SERVICE AGENCIES
IN ORANGE COUNTY, 1957

WATER SERVICE AGENCIES IN ORANGE COUNTY

1957

<u>Name and address of agency</u>	<u>Area irrigated, in acres</u>	<u>Number of services</u>
<u>Municipal Waterworks</u>		
City of Anaheim, Public Utilities Department 518 South Los Angeles Street, Anaheim	---	18,112
City of Brea 401 South Pomona Avenue, Brea	300	2,090
City of Buena Park 6650 Grand Avenue, Buena Park	---	6,462
City of Fullerton 237 West Commonwealth Avenue, Fullerton	278	13,512
City of La Habra City Hall, La Habra	---	4,723
City of Newport Beach, City Hall 3300 Newport Boulevard, Newport Beach	---	9,576
City of Orange City Hall, Orange	0	6,300
City of San Clemente City Hall, San Clemente	---	---
City of Santa Ana Room 204, City Hall, Santa Ana	---	21,550
City of Seal Beach City Hall, Seal Beach	---	1,159
<u>Commercial Water Companies</u>		
Dyke Water Company 11065 Penn Avenue, Garden Grove	210	19,698
Jones Water Company (P.U.) P. O. Box 444, El Modena	---	---
La Mirada Water Company (P.U.) 15075 Stage Road, La Mirada	0	1,881
J. Martinez Water System (P.U.) 1028 North Olive, Santa Ana	0	69

WATER SERVICE AGENCIES IN ORANGE COUNTY
(continued)

<u>Name and address of agency</u>	<u>Area irrigated, in acres</u>	<u>Number of services</u>
<u>Commercial Water Companies (continued)</u>		
Pacific Water Company (P.U.) 12061 East Bolsa Avenue, Santa Ana	---	3,873
Rancho Water Company (P.U.) P. O. Box 95, Tustin	---	420
San Juan Water Company (P.U.) 417 South Hill Street, Room 904, Los Angeles 13	10	1,113
Southern California Water Company 11911 South Vermont Street, Los Angeles 44	0	7,281
Sunset Land and Water Company (P.U.) P. O. Box 111, Sunset Beach	0	548
Tustin Water Works 235 East Main Street, Tustin	0	4,000
<u>Mutual Water Companies</u>		
Atwood Water Company 1108 North Oakdale, Fullerton	210	---
Associated Pumping Company 16402 East North Street, Route 4, Anaheim	120	---
Anaheim Eucalyptus Water Company 15161 Coronado, Anaheim	700	---
Anaheim Union Water Company 303 East Center Street, Anaheim	5,300	---
Ball and Dale Water Company 8532 East Ball Road, Anaheim	---	---
Batavia Water Company 9661 South Batavia, Orange	137	0
Benedict Water Company 9111 Winston Road, Anaheim	72	10

WATER SERVICE AGENCIES IN ORANGE COUNTY
(continued)

<u>Name and address of agency</u>	<u>Area irrigated, in acres</u>	<u>Number of services</u>
<u>Mutual Water Companies (continued)</u>		
Bishop Camp Water Company 4891 Camp Street, Cypress	3	11
Bolt Tract Water Company 9722 Walker, Anaheim	1	26
Boulevard Gardens Water Company 7742 Alhambra Avenue, Huntington Beach	1	143
Cameron Acres Mutual Water Company 17722 Huntington Beach Boulevard, Huntington Beach	---	20
Carroll Water Company Box 364, Anaheim	40	---
R. J. Cary Water Tract 7830 Newman Street, Huntington Beach	0	22
Catalina Street Pump Owners 14621 Verano, Santa Ana	0	26
Cerritos Domestic Water Company 10372 South Euclid, Anaheim	---	10
Cerritos Water Company 10162 Placentia, Route 4, Anaheim	---	---
Champion Pumping Plant 1791 West Broadway, Anaheim	17	5
Citrus Water Company 14661 East La Palma, Anaheim	65	2
Colonia Mutual Water Company 10761 Berry, Anaheim	---	134
Community Pumping Plant 13322 Paularino Avenue, Santa Ana	---	9
Community Water Supply Association 4541 La Palma, Buena Park	14	24
Cozard Pumping Plant 13301 East Garden Grove Boulevard, Route, Orange	40	8

WATER SERVICE AGENCIES IN ORANGE COUNTY
(continued)

<u>Name and address of agency</u>	<u>Area irrigated, in acres</u>	<u>Number of services</u>
<u>Mutual Water Companies (continued)</u>		
Crescent Water Association 8745 South Magnolia, Anaheim	15	5
Crone Avenue Pumping Plant 542 South West Street, Anaheim	45	---
Cypress Acres Water Association 4811 Grace Avenue, Buena Park	---	110
Dalewood Mutual Water Association 12821 Lorna Street, Garden Grove	---	100
Dawn Water Company 12331 South Meyer, Orange	175	14
Diamond Park Mutual Water Company 16442 Diamond Street, Santa Ana	0	96
Douglas Water Fund 14762 Wagner Avenue, Anaheim	80	4
Dunklee Lane Water Company 12091 Dunklee Land, Garden Grove	1	3
Eastside Water Association P. O. Box 81, Midway City	---	298
East Vermont Street Well 13086 East Vermont Street, Anaheim	---	---
Elaquador Irrigation Company 916 South West Street, Anaheim	36	0
Equitable Water Company 1801 Westwood Avenue, Santa Ana	100	3
Euclid Water Company 10702 Euclid Avenue, Anaheim	60	---
Eureka Water System 9652 Webster Street, Anaheim	20	17
Fairview Irrigation Plant 10781 9th Street, Anaheim	25	0

WATER SERVICE AGENCIES IN ORANGE COUNTY
(continued)

<u>Name and address of agency</u>	<u>Area irrigated, in acres</u>	<u>Number of services</u>
<u>Mutual Water Companies (continued)</u>		
Fairview Mutual Water Company 11341 Katella Avenue, Anaheim	3	5
Frances Mutual Water Company 4656 SE Irvine Boulevard, Santa Ana	1,250	0
Garden Grove Acres Water Company 14051 Bowen Street, Garden Grove	0	50
Garden Grove Irrigation Company P. O. Box 14, Garden Grove	48	15
Gay Street Water Association 8271 Gay Street, Buena Park	---	35
Gay Water Company 1855 West Orange Avenue, Anaheim	0	11
Gilbert Water Company 9112 East Berritos, Anaheim	36	---
Goodwin Mutual Water Company 210 West Commonwealth Avenue, Fullerton	54	0
Green Street Water Association 16762 South Hoskin, Route 1, Huntington Beach	---	15
Greenwald Mutual Water Company	---	---
Green Wing Land and Water Company 124 West 6th Street, Los Angeles	---	---
Hansen Water Company 7272 East Ball Road, Anaheim	---	---
Harding Water Company 9111 South Harding Avenue, Anaheim	0	21
Hellman Pump No. 5 11582 South Western Avenue, Anaheim	127	20
Hill Mutual Water Company 13411 Barrett Way, Garden Grove	---	---

WATER SERVICE AGENCIES IN ORANGE COUNTY
(continued)

<u>Name and address of agency</u>	<u>Area irrigated, in acres</u>	<u>Number of services</u>
<u>Mutual Water Companies (continued)</u>		
Hilltop Mutual Water Company 17411 Huntington Beach Boulevard, Huntington Beach	---	12
H & M Water Company 311 South Placentia, Anaheim	0	16
Holder Place Mutual Water System 7652 Holder Place, Buena Park	0	11
Holder Road Water Company 9111 Holder Road, Anaheim	0	10
Homewood Mutual Water Company 6131 Marshall Avenue, Buena Park	0	580
Hudson Lane Mutual Water Company 10002 South Gilbert, Anaheim	0	7
Hynes Estate Water Company 8281 Hynes Road, Anaheim	---	32
Ideal Water Company 1413 Westmont Avenue, Anaheim	50	0
Karen Street Water Company 5551 Karen Avenue, Cypress	0	14
Katella Water Company, Inc. 8101 South Rio Vista Street, Anaheim	62	0
Kellogg Water Company 10082 South Nutwood, Route 1, Anaheim	61	9
K & L Water Company 13572 Katella, Anaheim	45	4
Lampson Magnolia Water Company 9101 Lampson Street, Garden Grove	---	---
L & D Water Association 4552 East Lincoln, Buena Park	0	8
Liberty Park Water Association 7772 Liberty Street, Huntington Beach	---	55

WATER SERVICE AGENCIES IN ORANGE COUNTY
(continued)

<u>Name and address of agency</u>	<u>Area irrigated, in acres</u>	<u>Number of services</u>
<u>Mutual Water Companies (continued)</u>		
Lincoln Water Association 8052 Lincoln, Anaheim	---	---
Lobo Water Company 10531 Lexington Street, Anaheim	---	22
Luce Water Company 9611 Lincoln, Anaheim	---	---
Magnolia Lincoln Water Association 9052 South Magnolia, Anaheim	2	5
Magnolia Mutual Water Company 2615 West Orangethorpe, Fullerton	---	12
Magnolia Mutual Water Company 10822 Magnolia, Anaheim	30	---
Magnolia Pumping Plant 9001 East Lincoln, Anaheim	85	0
Maybury Tract Well Company P. O. Box 84, Santa Ana	18	0
Midway City Mutual Water Company P. O. Box 21, Midway City	10±	191
Miller Water Company 1885 West Ball Road, Anaheim	20	1
Moffit and Prell Water Company	---	---
Moody Mutual Water Association 8111 Moody, Buena Park	0	17
Mores Mutual Water Company 17091 Ash Street, Huntington Beach	---	---
Mutual Water Company 13372 Winston, Anaheim	112	0
Mutual Water Company 18131 3rd Street, Route 3, Santa Ana	---	---

WATER SERVICE AGENCIES IN ORANGE COUNTY
(continued)

<u>Name and address of agency</u>	<u>Area irrigated, in acres</u>	<u>Number of services</u>
<u>Mutual Water Companies (continued)</u>		
Mutual Water Company of Landsdowne 3513 Flower Avenue, Fullerton	---	259
Mutual Water Company of Stanton P. O. Box 22, Stanton	0	45
Newhope Mutual Water Company 15136 South Newhope, Santa Ana	20	0
North East Water Company 1349 East La Palma, Anaheim	3	4
North Street Co-Partnership Pumping Plant 1135 West North Street, Anaheim	5	0
Nutwood Mutual Water Company 10701 South Nutwood, Anaheim	70	3
Ocean View Mutual Water Company 17022 A. Street, Huntington Beach	0	29
Orange Avenue Water Company	---	---
Orange Grove Water Company 9002 Rio Vista Street, Anaheim	118	11
Orangewood Water Company 13041 Chapman Avenue, Anaheim	49	10
Orchard Park Acres Mutual Water Company 2119 North Main Street, Santa Ana	800	0
Orchard Park Water Company 9951 Harbor Boulevard, Anaheim	---	---
Page Avenue Mutual Water Company 9952 East Page Avenue, Fullerton	33	28
Palm Mutual Water Company 6721 Orange Avenue, Route 2, Anaheim	---	---
Parkview Mutual Water Company, Inc. 16911 "A" Street, Huntington Beach	4	11

WATER SERVICE AGENCIES IN ORANGE COUNTY
(continued)

<u>Name and address of agency</u>	<u>Area irrigated, in acres</u>	<u>Number of services</u>
<u>Mutual Water Companies (continued)</u>		
Paw Paw Mutual Irrigation Company P. O. Box 288, Fullerton	31	0
Peltzer Pumping Plant 1530A Valencia, Fullerton	---	---
Peralta Hills Water Company P. O. Box 448, Orange	394	62
Pilot Water Company 16651 North Street, Route 4, Anaheim	300	---
Pine Water Company 13181 Chapman Street, Orange	0	5
Placentia Mutual Water Company 6862 Miller, Route 1, Placentia	---	---
Plaza Rancho Pumping Plant 523 South Sillivan Street, Santa Ana	22	---
Pyne Ranch Mutual Water Company 20252 Santa Ana Canyon Road, Anaheim	165	---
Rancho Lomita, Inc. Suite 636, 550 South Flower Street, Los Angeles 17	275	1
Red Hill Water Company Box 175, Tustin	1,000	0
R. P. Rees Water Company 8742 Lincoln, Anaheim	5	2
Richfield Mutual Water Company 601 Haas Bldg., 219 W. 7th Street, Los Angeles 14	150	0
Rio Vista Water Company 8771 South Rio Vista, Anaheim	123	1
Romneya Drive Mutual Water Company 1220 West Romneya Drive, Anaheim	7	4
Salter Pump Plant 707 North Resh, Anaheim	65	---

WATER SERVICE AGENCIES IN ORANGE COUNTY
(continued)

<u>Name and address of agency</u>	<u>Area irrigated, in acres</u>	<u>Number of services</u>
<u>Mutual Water Companies (continued)</u>		
Santa Ana Heights Water Company 1126 S. E. Palisades Road, Santa Ana	---	1,606
Santa Ana Valley Irrigation Company 154 North Glassell Street, Orange	13,379	
Santiago Water Company P. O. Box 444, El Modena	0	465
Savannah Mutual Water Company 6831 Savannah Street, Anaheim	15	33
Schneider-Hargrove Water Company 1700 Los Angeles Street, Anaheim	11	4
Schroeder Pumping Plant 2143 West Broadway, Anaheim	27	0
Section Two Water Company 7462 Baxter Street, Anaheim	108	35
Section 13 Water Company 9362 South Rio Vista, Anaheim	196	10
Section 16 Water Company 1791 West Broadway, Anaheim	20	4
Section 18 Water Company 9762 Orange Avenue, Anaheim	13	2
Sloan Ranch Mutual Water Company 6152 Grand Avenue, Buena Park	---	160
South Midway City Water Company 15061 South Jackson, Box 186, Midway City	0	68
South Main Mutual Water Company 2019 Hickory Street, Santa Ana	0	384
Southwestern Mutual Water Company 16391 South Fairview Road, Santa Ana	0	220
Star Farms Mutual Water Company 8101 Starr Street, Route 1, Anaheim	---	---

WATER SERVICE AGENCIES IN ORANGE COUNTY
(continued)

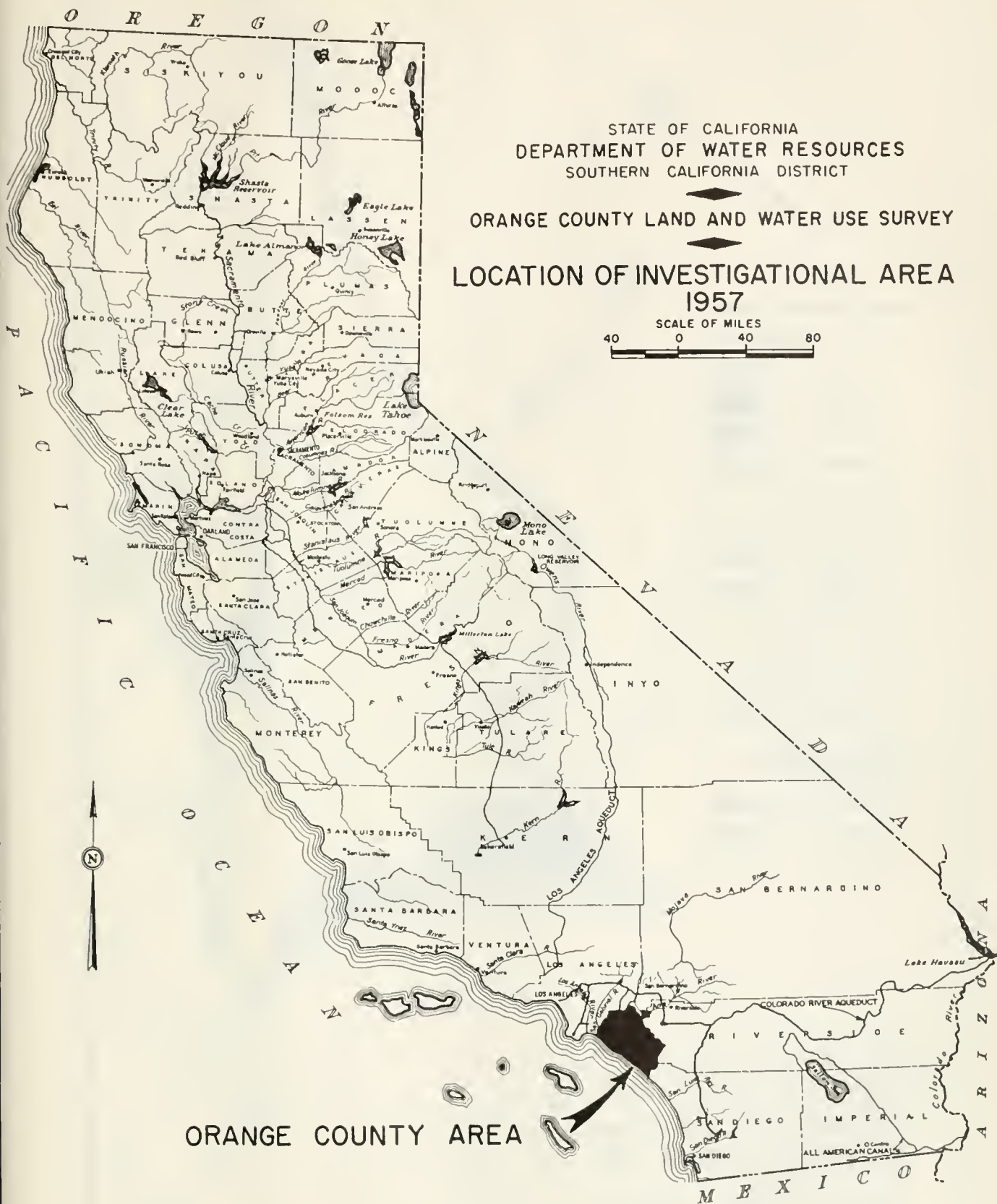
<u>Name and address of agency</u>	<u>Area irrigated, in acres</u>	<u>Number of services</u>
<u>Mutual Water Companies (continued)</u>		
Sugar Avenue Pumping Plant Association 11851 Sugar Avenue, Santa Ana	50	---
Tract 1052 Mutual Water Association 12631 Lorna Street, Garden Grove	10	60
Tract 1322 Water System 11151 Cerritos, Anaheim	---	---
Trask Avenue Pumping Plant P. O. Box 146, Garden Grove	44	10
Triangle Acres Water Company 9591 Holder, Anaheim	13	18
Triangle Water Company 9761 Beverly Lane, Gardena	85	---
Turner Mutual Water Company Box 175, Tustin	50	---
Tustin Mutual Water Works Box 95, Tustin	---	---
Tye Water Company 1530 Avolencia, Fullerton	131	---
United Water Association of Stanton 11292 Western, Anaheim	---	3
Valencia Water Company 8562 Rio Vista Avenue, Route 4, Anaheim	---	---
Visco Products Company, Inc. 400 East Vermont Street, Anaheim	8	1
Vista del Rio Rancho Water Group 21252 Santa Ana Canyon Road, Anaheim	102	23
V. & M. Water Company 9231 Cerritos, Anaheim	14	3
Wait Water Plant 12412 Stanton Avenue, Garden Grove	0	12

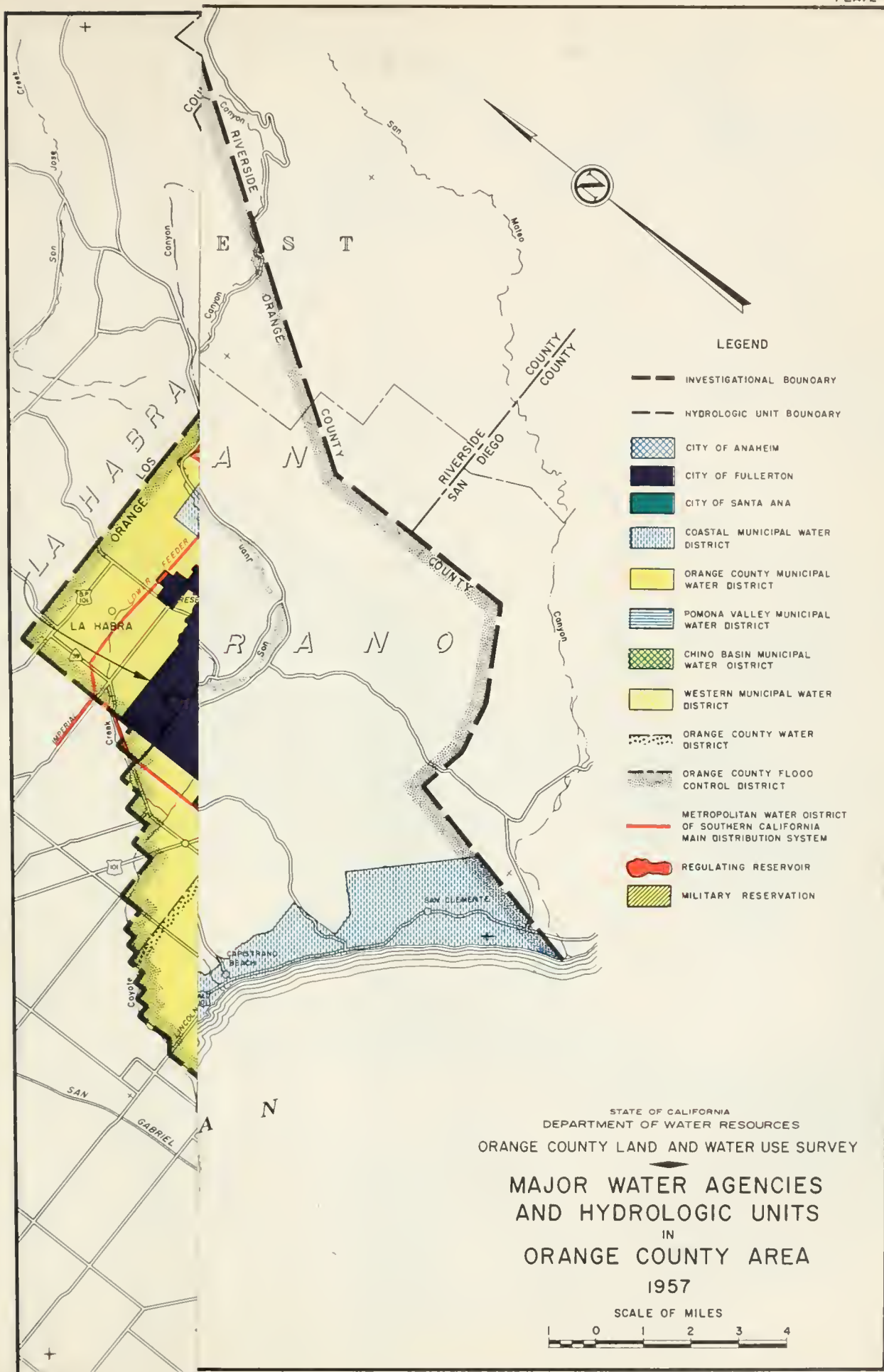
WATER SERVICE AGENCIES IN ORANGE COUNTY
(continued)

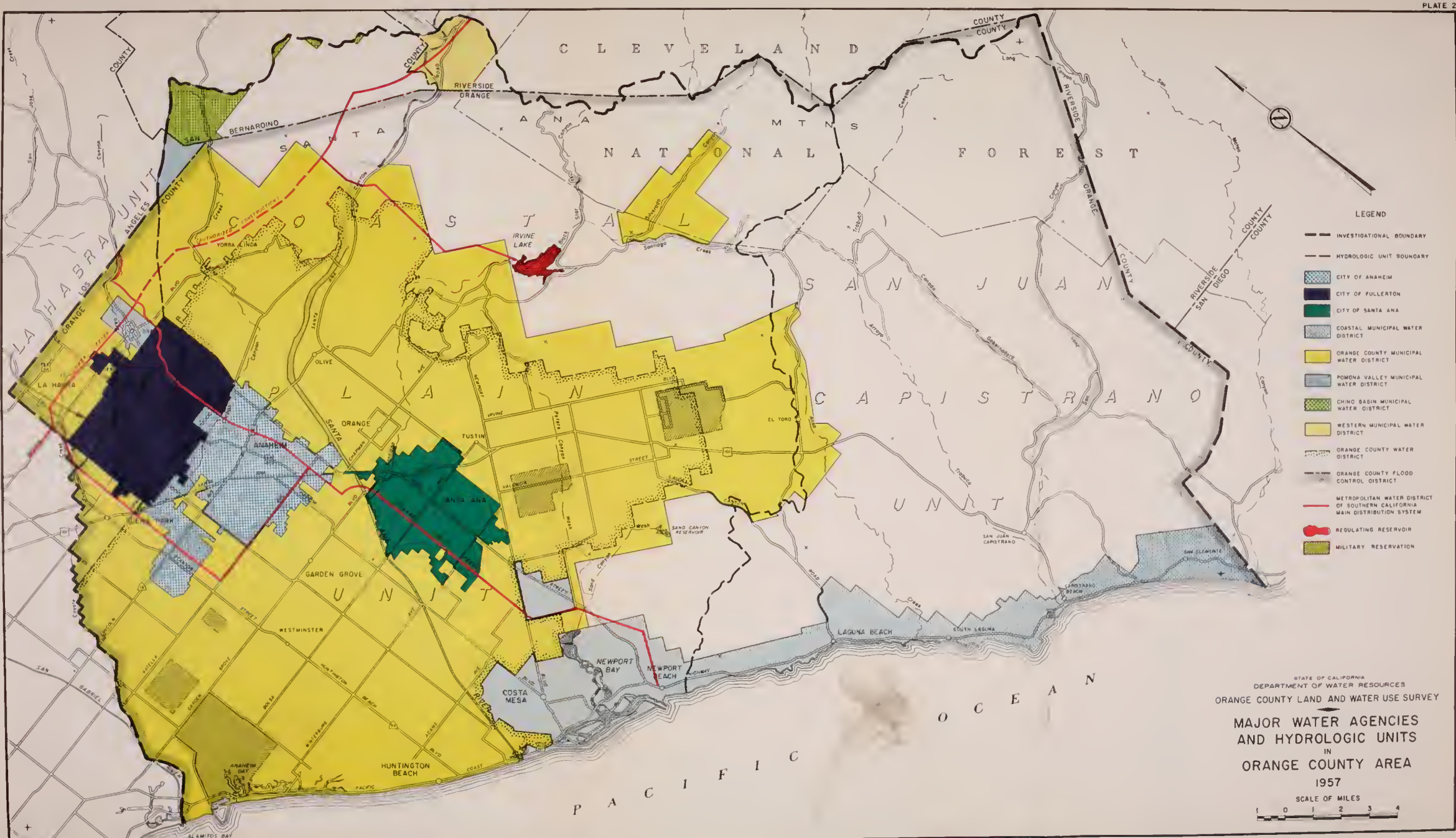
<u>Name and address of company</u>	<u>Area irrigated, in acres</u>	<u>Number of services</u>
<u>Mutual Water Companies (continued)</u>		
Webster Tract Water System 9892 South Webster, Anaheim	---	---
West Anaheim Water Company 1600 West Broadway, Anaheim	118	---
West First Street Water Company 15122 South Harbor Boulevard, Santa Ana	7	9
West Street Water Company 1057 West Ball Road, Anaheim	2	0
W. H. C. Water Company 8471 Rio Vista, Route 4, Anaheim	---	---
Wilminedi Water Company 1801 North Westwood Avenue, Santa Ana	100	2
Winchica Community Water Company 5065 Wintersburg Road, Huntington Beach	---	20
Wintersburg Community Water Works 7542 Washington Avenue, Huntington Beach	--	---
Yorba Linda Water Company P. O. Box 8, Yorba Linda	2,600	839
<u>County Water Districts</u>		
Fairview County Water District 1971 Placentia Avenue, Costa Mesa	10	2,747
Laguna Beach County Water District 306 Third Street, Laguna Beach	0	4,573
Newport Mesa County District 543 West 18th Street, Costa Mesa	0	659
Orange County Water District No. 2 Buena Park	---	---
Orange County Water Works District No. 3 11061 Garden Grove Boulevard, Garden Grove	---	6,400

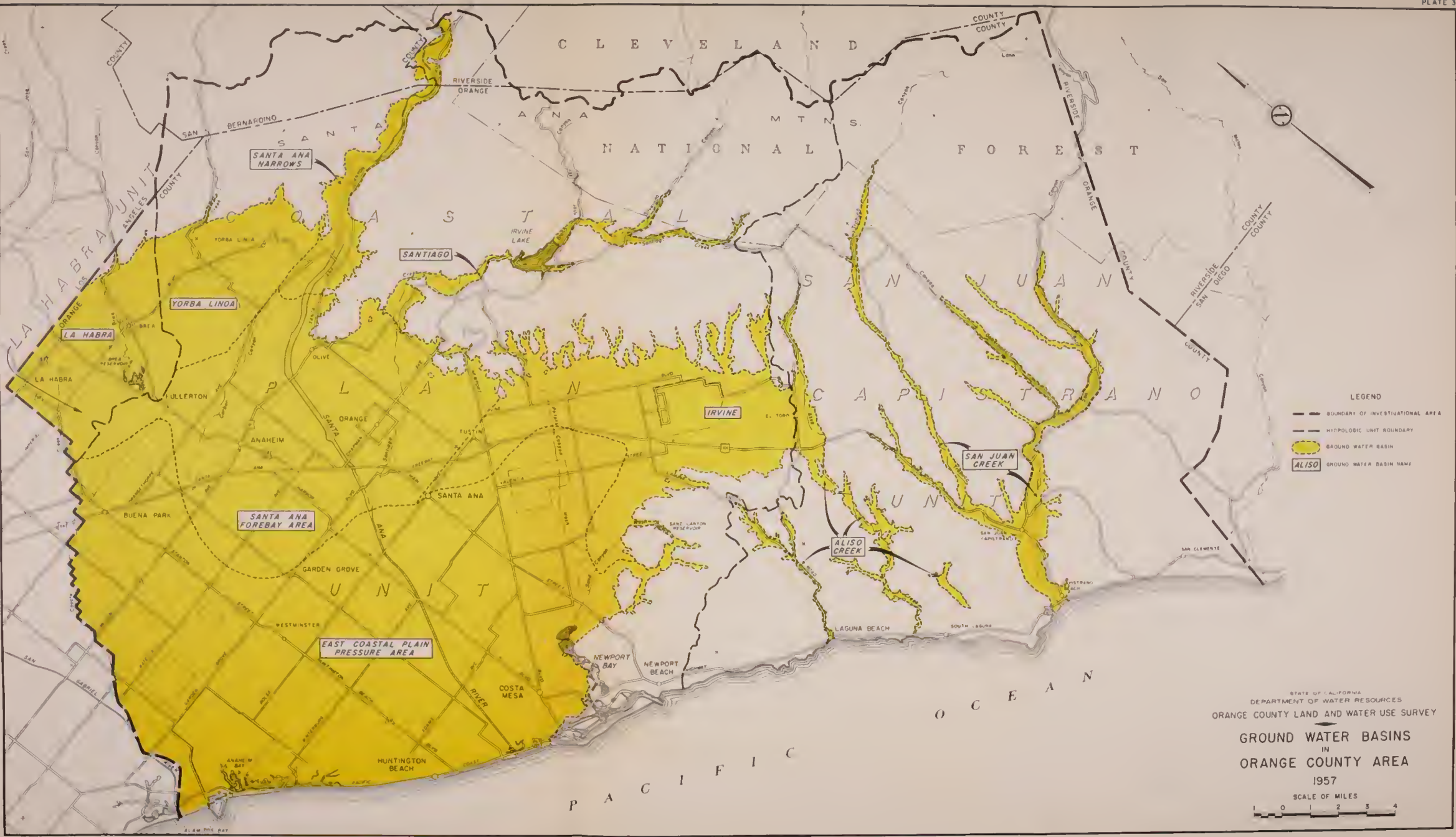
WATER SERVICE AGENCIES IN ORANGE COUNTY
(continued)

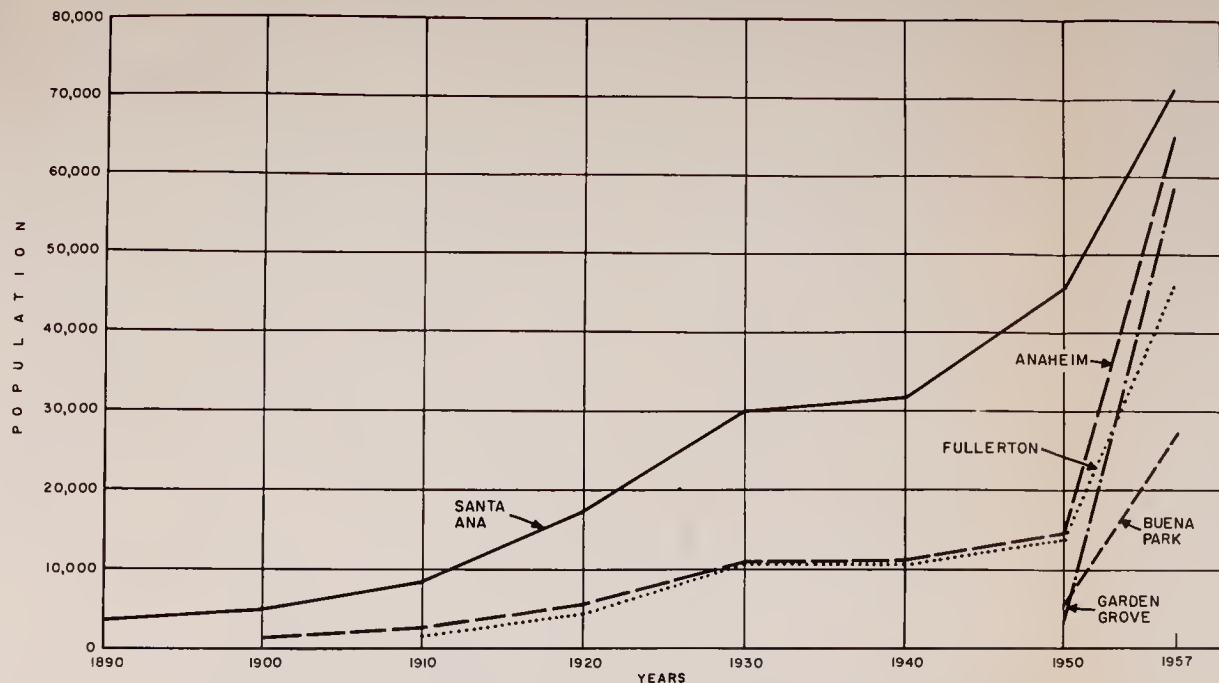
<u>Name and address of agency</u>	<u>Area irrigated, in acres</u>	<u>Number of services</u>
<u>County Water Districts (continued)</u>		
Orange County Water Works District No. 4 San Juan Capistrano	---	302
Orange County Water Works District No. 5 7111 Wyoming Street, Westminster	0	773
Orange County Water Works District No. 7 128 West Sycamore Street, Anaheim	---	190
Orange County Water Works District No. 8 12822 South Barrett Lane, Santa Ana	---	332
South Coast County Water District 31652 Second Avenue, South Laguna	0	1,197
<u>Irrigation Districts</u>		
Carpenter Irrigation District Route 1, Box 152, Orange	---	---
Newport Heights Irrigation District 116 East 18th Street, Costa Mesa	10	3,680
Serrano Irrigation District Box 18021 East Lincoln Street, Orange	1,497	219
<u>Municipal Water Districts</u>		
Coastal Municipal Water District Laguna Beach, etc.	(Sells at wholesale)	
Orange County Municipal Water District Placentia, etc.	(Sells at wholesale)	
<u>Metropolitan Water Districts</u>		
The Metropolitan Water District of Southern California (Sells at wholesale)		



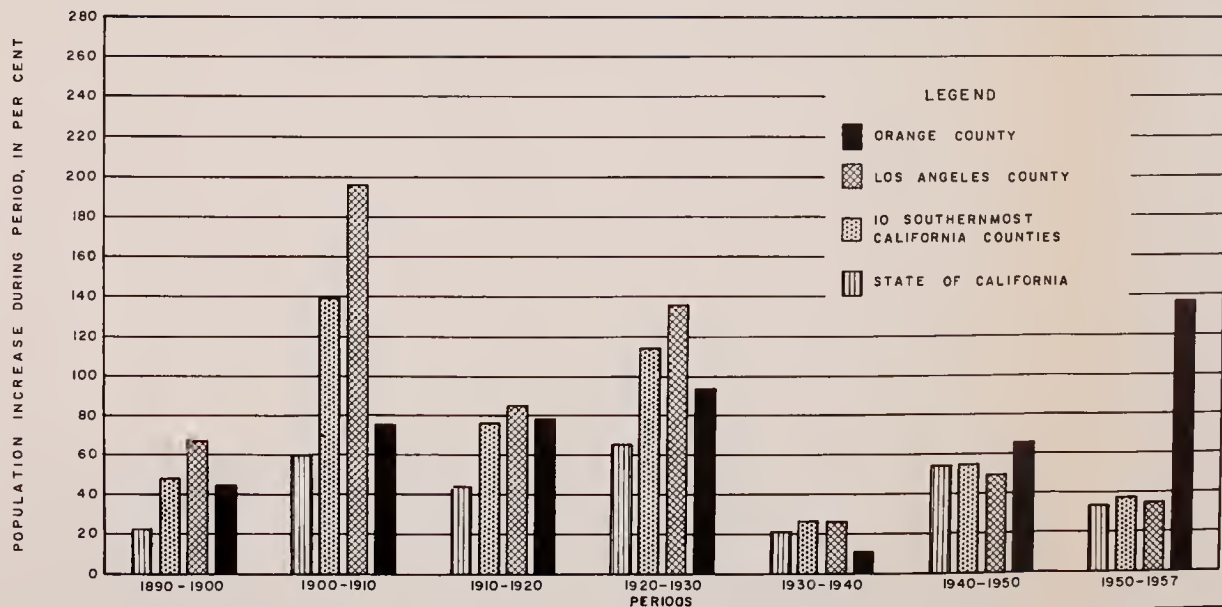




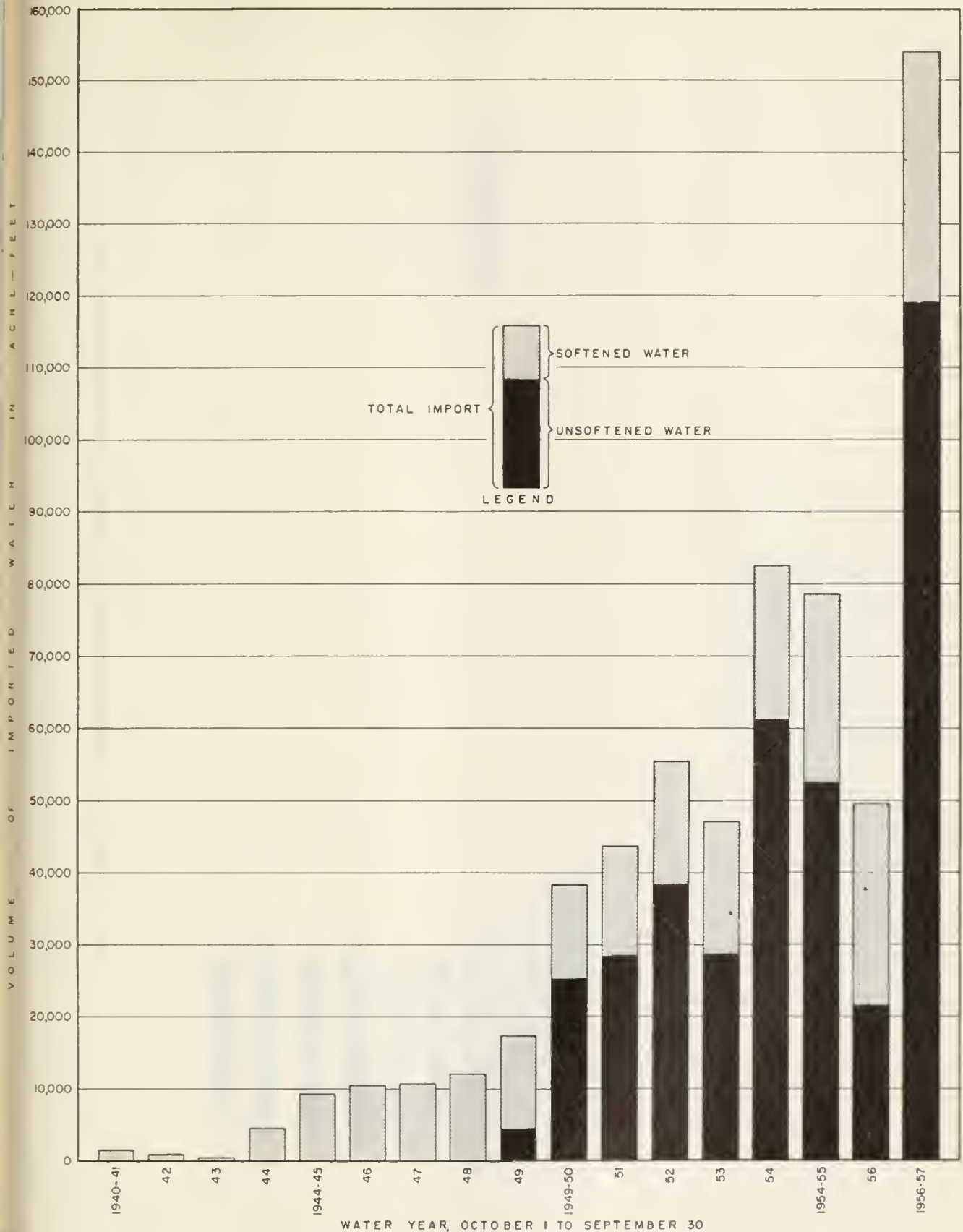




POPULATION GROWTH OF PRINCIPAL INCORPORATED CITIES IN ORANGE COUNTY



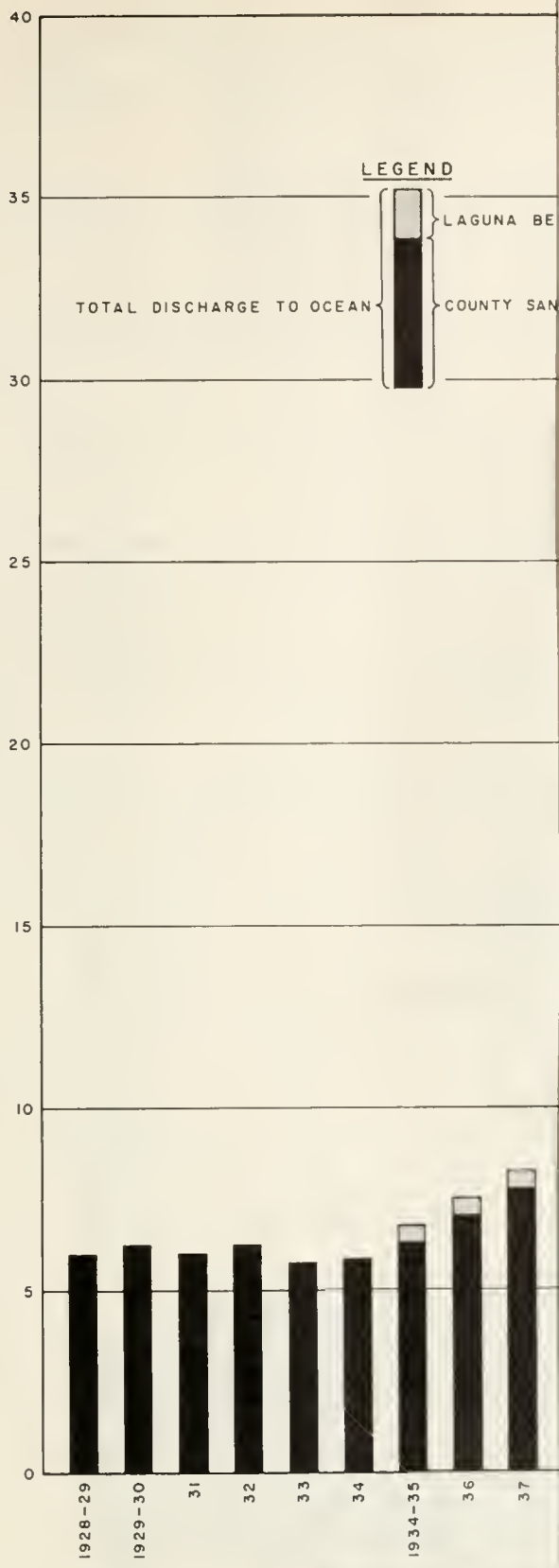
COMPARISON OF POPULATION INCREASES OF ORANGE COUNTY WITH THOSE OF LOS ANGELES COUNTY, 10 SOUTHERNMOST CALIFORNIA COUNTIES AND STATE OF CALIFORNIA



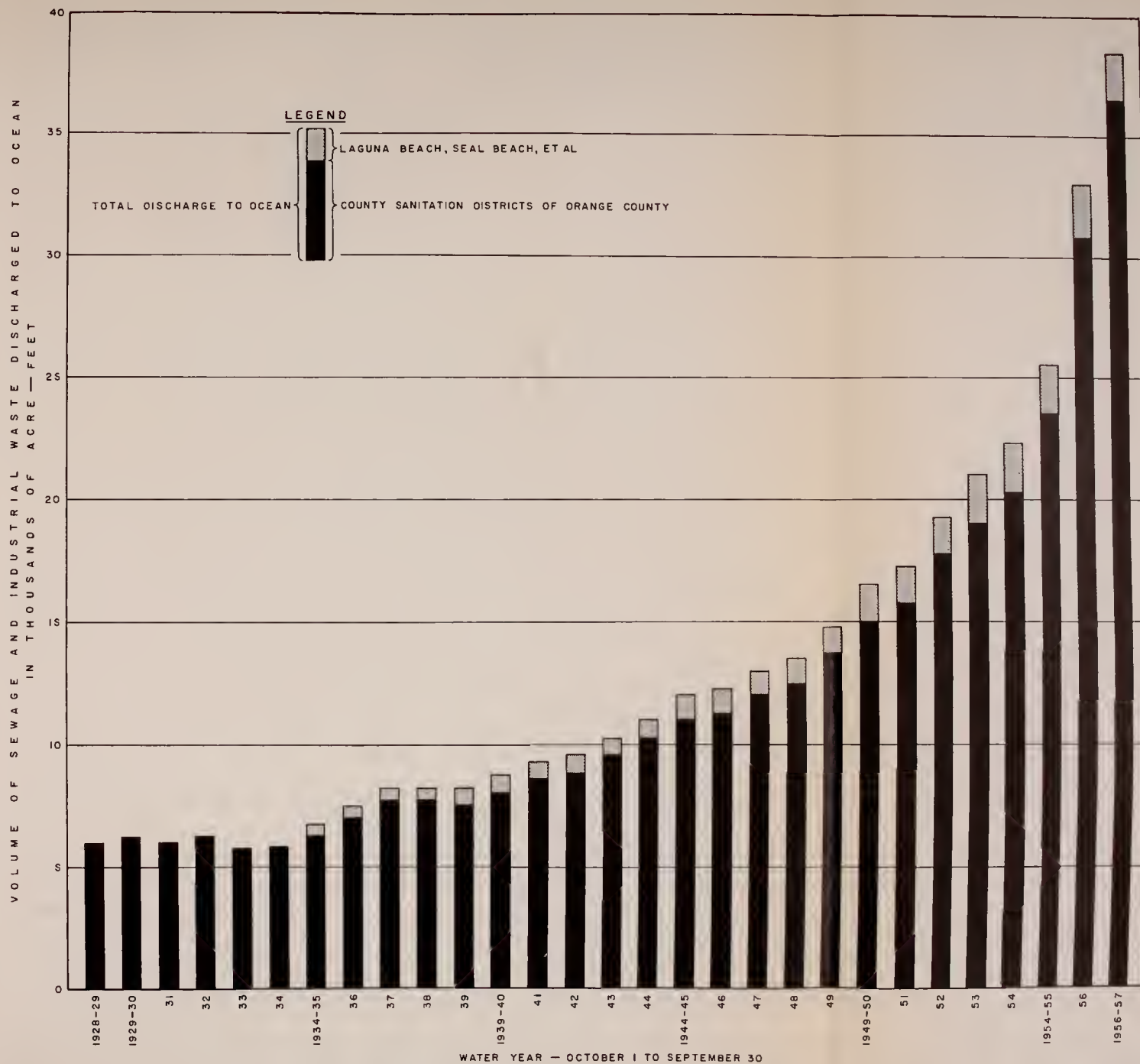
HISTORICAL IMPORTATIONS OF WATER
TO ORANGE COUNTY



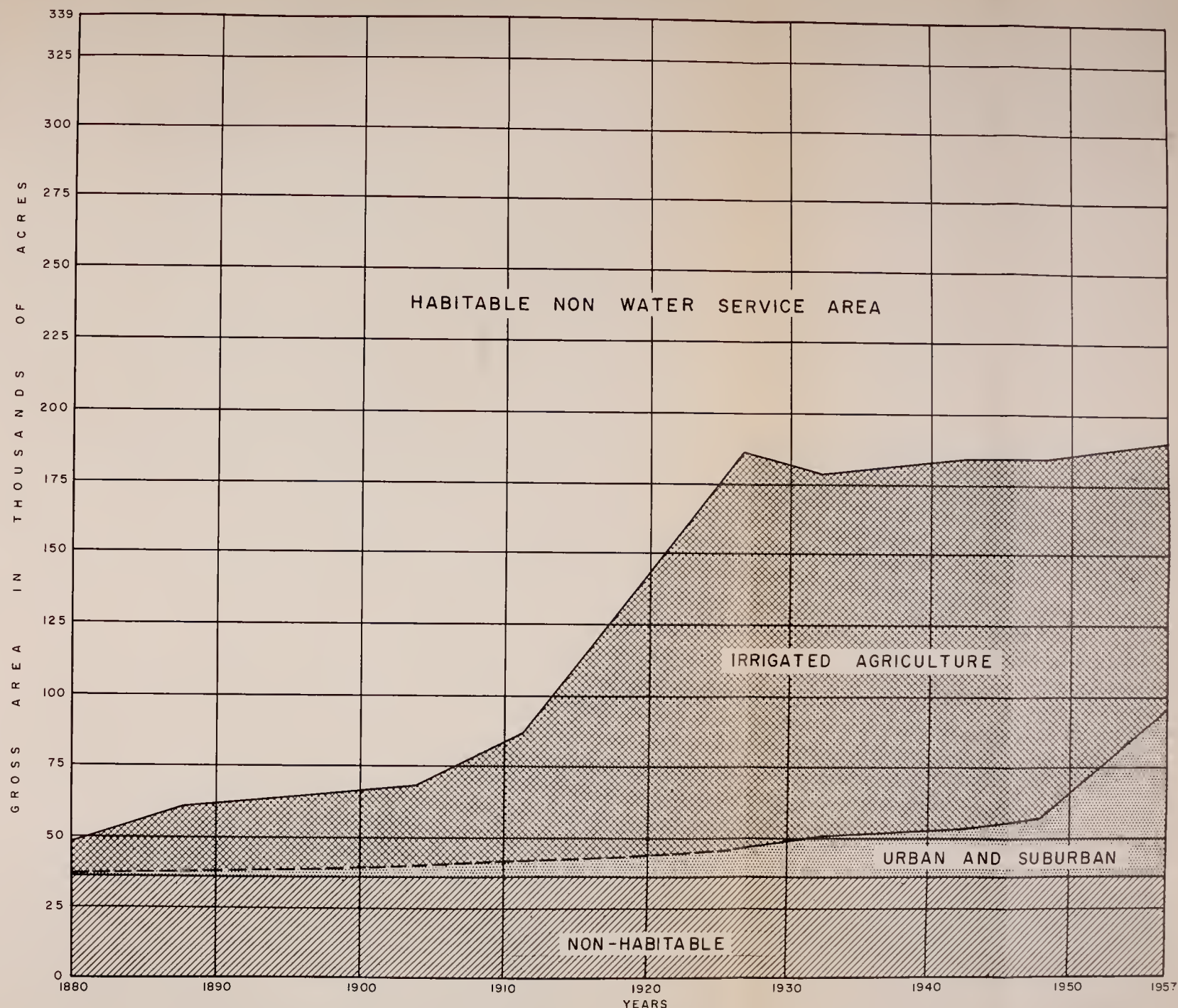
VOLUME OF SEWAGE AND INDUSTRIAL WASTE DISCHARGED TO OCEAN
IN THOUSANDS OF ACRES — FEET



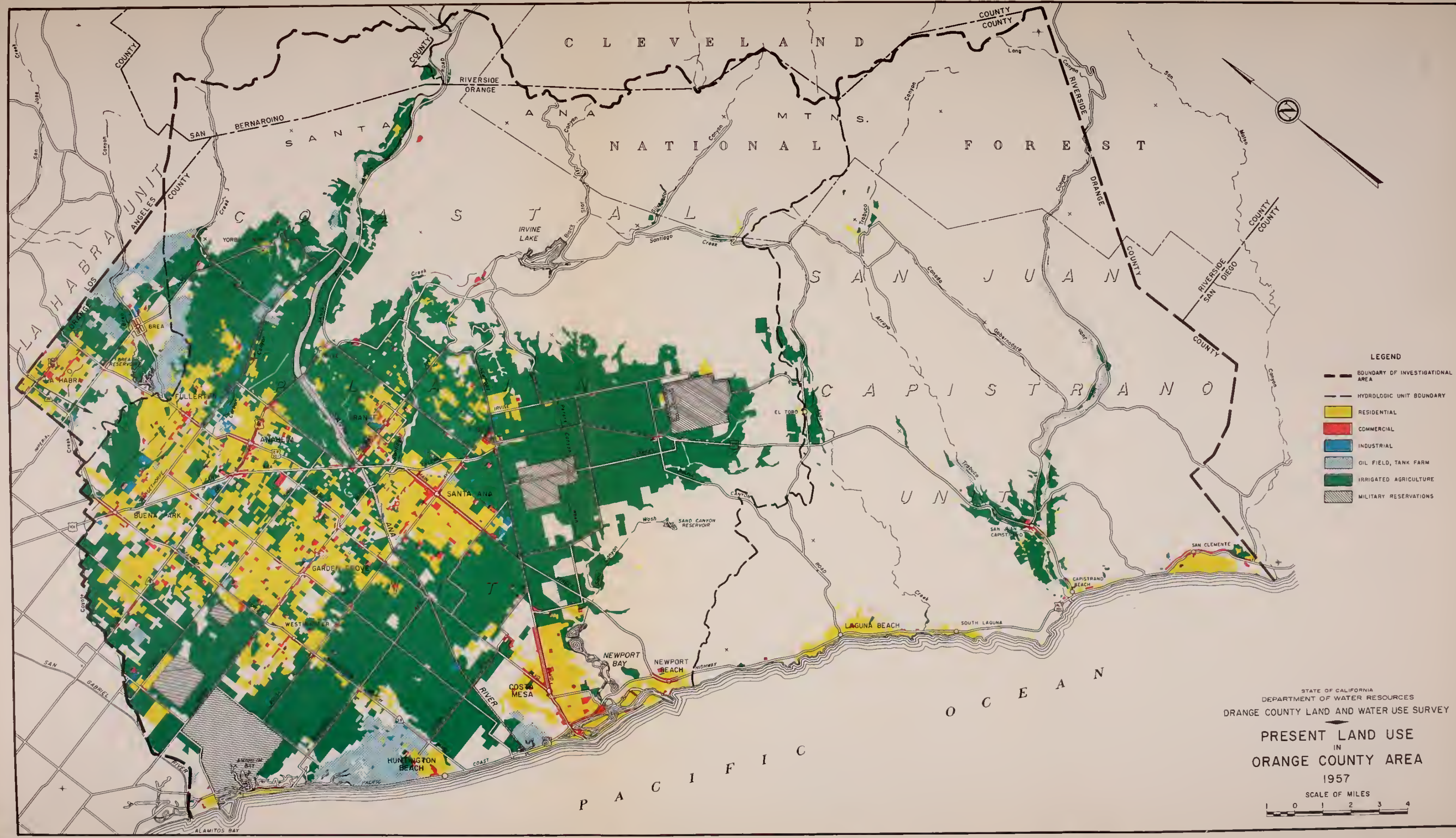
HISTORICAL DIS
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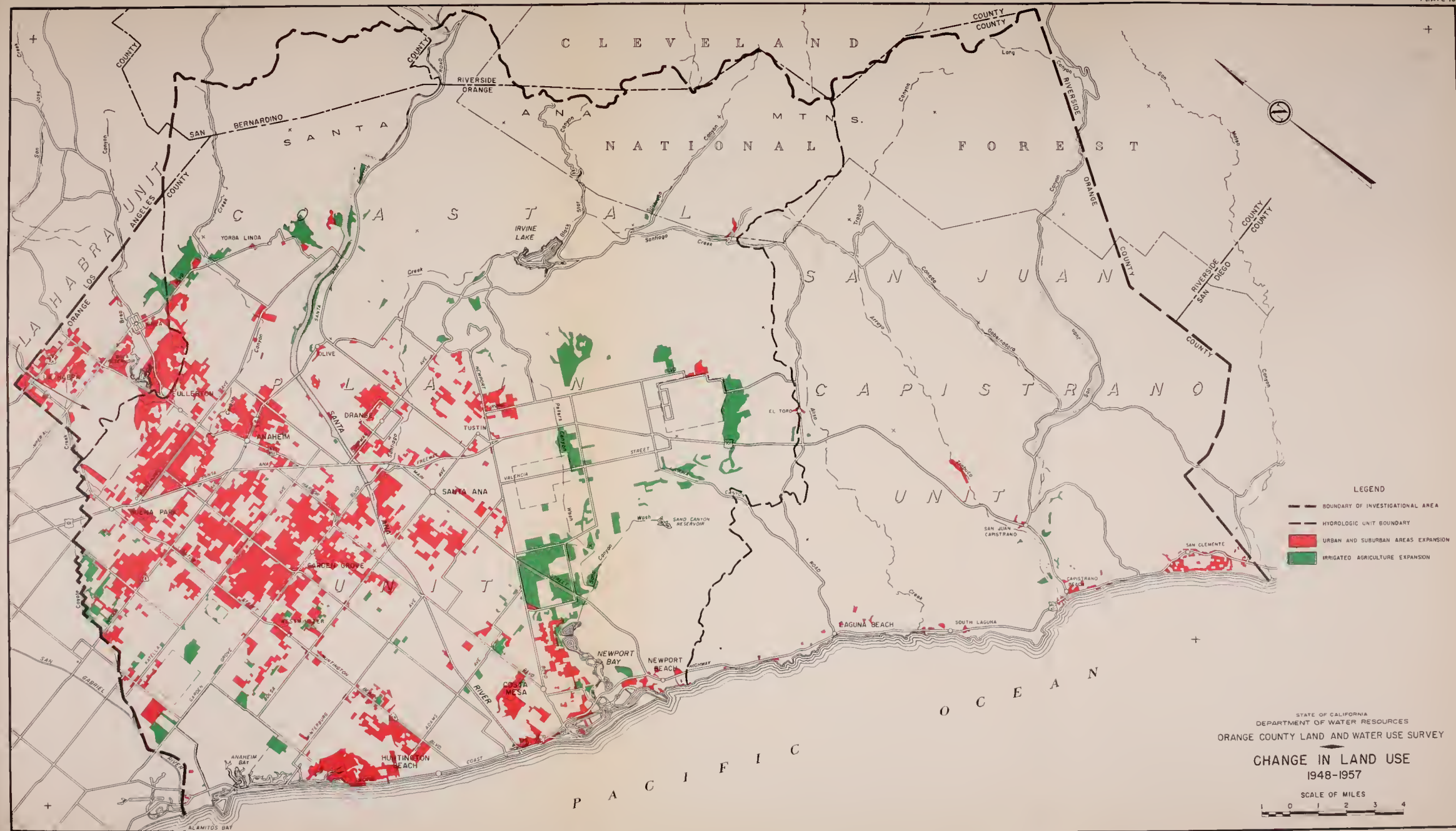


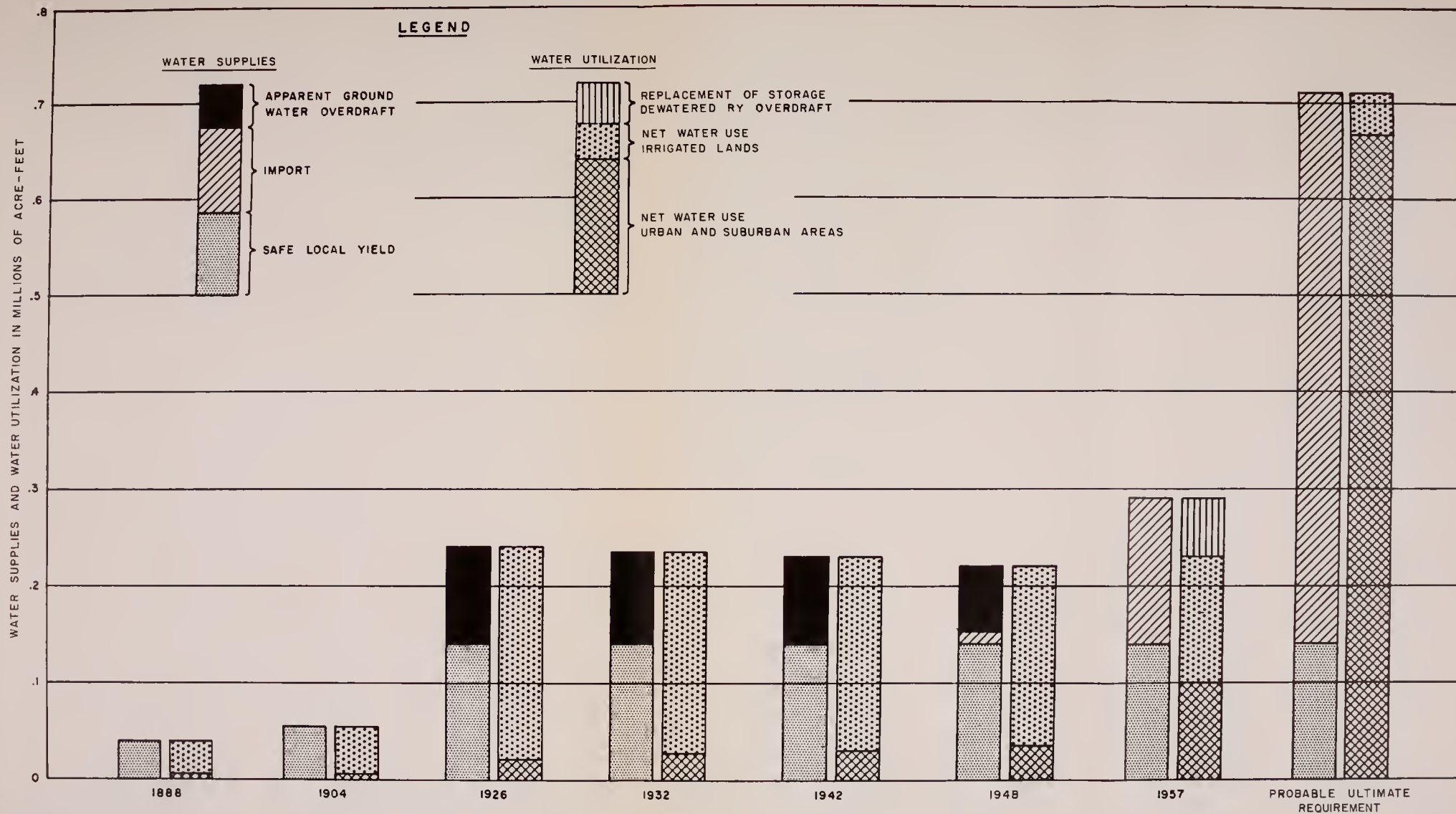
HISTORICAL DISCHARGE OF SEWAGE AND INDUSTRIAL WASTE TO OCEAN FROM ORANGE COUNTY



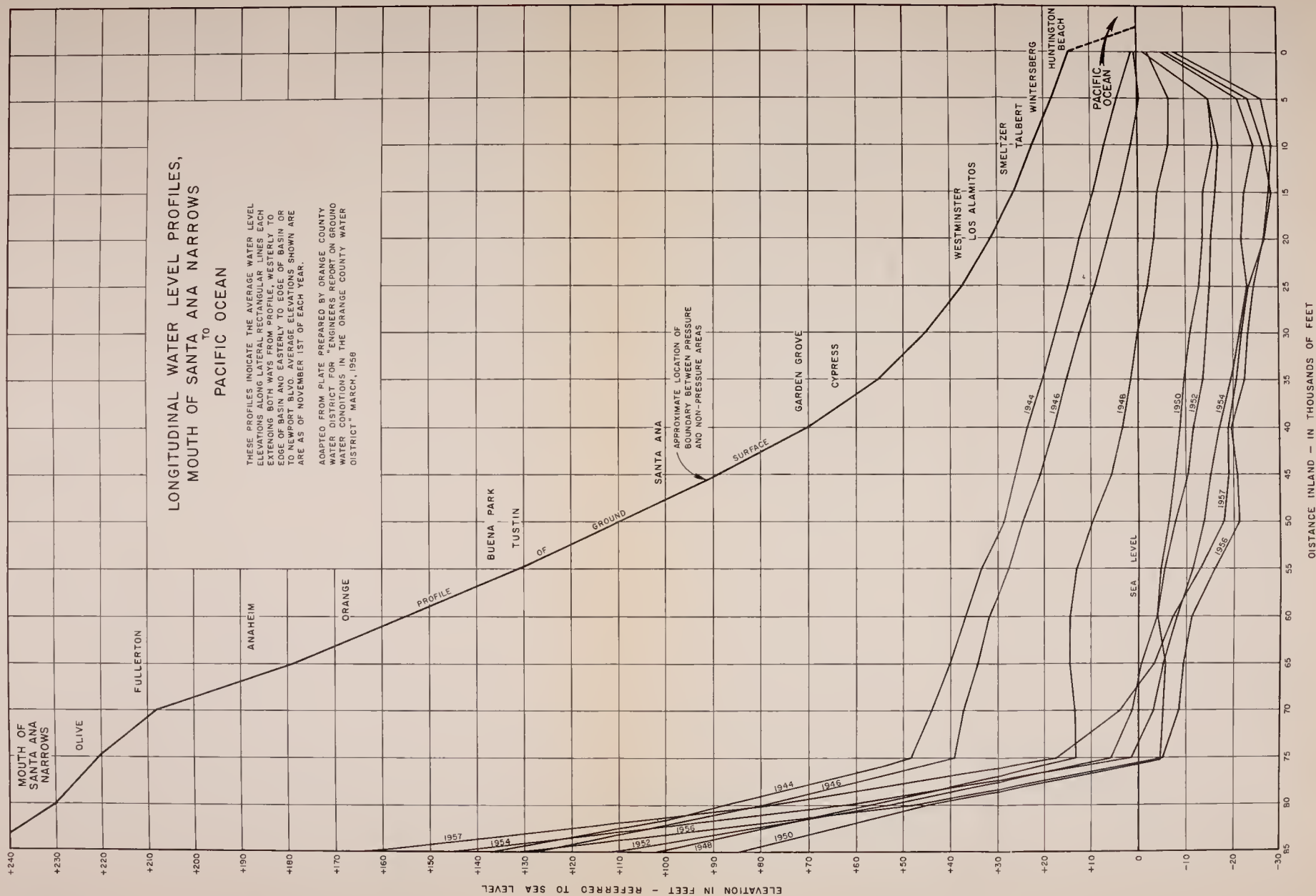
HISTORICAL CHANGE IN PATTERN OF LAND USE
IN ORANGE COUNTY COASTAL PLAIN AREA







WATER SUPPLIES AND ESTIMATED WATER UTILIZATION
ORANGE COUNTY COASTAL PLAIN



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